JAN 21 1924

PRINTED ON THIN PAPER FOR FOREIGN CIRCULATION.

Engineering Library

# ENGINEERING:

## An Illustrated Weekly Journal.

*EDITED BY WILLIAM H. MAW AND ALEX. RICHARDSON.*

OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 35 & 36, BEDFORD STREET, STRAND, LONDON, W.C.2.

VOL. CXVI.—No. 3026.] *LONDON: FRIDAY, DECEMBER 28, 1923.* [*Registered at the General Post Office as a Newspaper.*] [PRICE ... 1s. BY FOREIGN POST 1s. 3d.

Aveling & Porter, Ltd.,
ROCHESTER.

Steam & Crude Oil Rollers.
SPECIAL ROLLERS FOR BITUMINOUS ROADS. 1108

A. G. Mumford, Ltd.,
CULVER STREET WORKS, COLCHESTER.
On Admiralty and War Office Lists.
ENGINES for Torpedo Boats, Yachts, Launches.
BOILER FEED PUMPS.
See advertisement page 18.
PATENT WATER-TUBE BOILERS.
AUTOMATIC FEED REGULATORS.
And Auxiliary Machinery as supplied to the Admiralty. 2179

Dredging Plant
OF ALL DESCRIPTIONS.
FLOATING CRANES. COAL BUNKERING VESSELS.
Werf Conrad, HAARLEM, HOLLAND.
Agents: MARINE WORKS, Ltd., Friars House, 39-41, New Broad St., LONDON, E.C.2.
See half-page Advert. last week and next week. 1382

CRANES. All Types.
GEORGE RUSSELL & CO., LTD., Motherwell. 1137

STEEL TANKS, PIPES, GASHOLDERS, &c.
Thos. Piggott & Co., Limited, BIRMINGHAM. 1341
See Advertisement last week, page 90.

Spencer-Hopwood & Kirke PATENT BOILERS See Page 71. 1293
Sole Makers: SPENCER-BONECOURT, Ltd., Parliament Mansions, Victoria St., London, S.W.

Tank Locomotives.
Specification and Workmanship equal to Main Line Locomotives.
R. & W. HAWTHORN, LESLIE & CO. Ltd., Engineers, Newcastle-on-Tyne. 1133

Cochran MULTITUBULAR AND CROSS-TUBE TYPES. Boilers.
See page 17. 1134

E. J. Davis, M.I.Mech.E., Gas Engines Inspected, Tested and Reported upon. Over 25 years' experience. Tel.: Maryland 1736 & 1737. Wire: "Rapidising, London." —Great Eastern Road, Stratford, E. 15. 1794

Brett's Patent Lifter Co. Limited.
Hammers, Presses, Furnaces,
COVENTRY. 610

Invincible Gauge Glasses.
*BUTTERWORTH BROS., Ltd., Newton Heath Glass Works, Manchester.* Od 9753

GEARS OF EVERY DESCRIPTION.
Spring Grove, AUTOGEARS (Leeds), Ltd., Hyde Park Road, Leeds. 1743

Fuller, Horsey, Sons & Cassell.
SPECIALISTS in the SALE AND VALUATION of PLANT AND MACHINERY and ENGINEERING WORKS.
11, BILLITER SQUARE, E.C.3. 1834

Iron and Steel
Tubes and Fittings.
Sole Licensees in Great Britain for the manufacture of "Armco" Rust and Corrosion Resisting Iron Tubes. 317
The Scottish Tube Co., Ltd.,
Head Office: 34, Robertson Street, Glasgow.
See Advertisement, page 79, Dec. 21.

YARROW & Co. (1922), LTD., GLASGOW.
PASSENGER AND CARGO STEAMERS.
SHALLOW DRAFT VESSELS. 1553

Campbells & Hunter, Ltd.
Gear Cutting.
Worm Wheels cut up to 13 ft. diam.
Bevel and Mitre Wheels planed up to 3 ft. diam.
Spur Wheels cut up to 9 ft. diam
DOLPHIN FOUNDRY, LEEDS. 4547

VOSPER & Co., LTD.,
PORTSMOUTH.
SHIP & LAUNCH BUILDERS, Od 3551
ENGINEERS & BOILER MAKERS.

The Glasgow Rolling Stock and Plant Works.
Hurst, Nelson & Co., Ltd.,
Builders of RAILWAY CARRIAGES, WAGONS ELECTRIC CARS, and EVERY OTHER DESCRIPTION OF RAILWAY and TRAMWAY ROLLING STOCK.
Makers of Wheels and Axles, Railway Plant, Forgings, Smith Work, Iron & Brass Castings.
Pressed Steel Work of all kinds.
Registered Office and Chief Works: Motherwell.
London Office: 14, Leadenhall Street, E.C. Od3382

OIL FUEL APPLIANCES,
*Systems*
PRESSURE, AIR, STEAM
*For Boilers of all types.*
KERMODES LIMITED,
35, The Temple, Dale Street, Liverpool.
*Naval Outfits a Speciality*, also for Merchant Ships, for Factories, Locomotives, and Industrial Process Furnaces of all kinds.
Supplied to the British and other Governments.
Telephone No.: Central 2832.
Telegrams: "Warmth." 4078

Locomotives Tank Engines
designed and constructed by
MANNING, WARDLE AND COMPANY, LIMITED,
Boyne Engine Works, Leeds. Od. 2457
See their Illus. Advertisement, page 93, last week.
RAILWAY AND TRAMWAY ROLLING STOCK.
Hurst, Nelson & Co., Ltd.
The Glasgow Rolling Stock and Plant Works, Motherwell. Od 3383

R. Y. Pickering & Co., Ltd.
(Established 1864.)
BUILDERS of RAILWAY CARRIAGES & WAGONS
MAKERS of WHEELS and AXLES of all kinds.
RAILWAY WAGONS FOR HIRE.
Chief Works and Offices:
WISHAW, near GLASGOW.
London Office: Od 3353
3, Victoria Street, Westminster, S.W.

P. & W. MacLellan, Ltd.,
CLUTHA WORKS, GLASGOW.
Manufacturers of
RAILWAY CARRIAGES AND WAGONS
OF EVERY DESCRIPTION.
RAILWAY IRONWORK, BRIDGES, ROOFING, &c.
Chief Offices: 129, Trongate, Glasgow. Od 8547
Registered Offices: Clutha House, 10, Princes St., Westminster, S.W.1.

'Phone—Holb. 541. Tele.—Andrubo, Holb., London.
Andrews & Beaumont,
CHARTERED PATENT AGENTS, 1292
26, Southampton Buildings, London, W.C. 2.

ON ADMIRALTY LIST.
John Kirkaldy, Ltd.,
London Office: 101, Leadenhall St., E.C. 3.
Works: Burnt Mill, near Harlow, Essex.
Makers of
Evaporating and Distilling Plants.
Refrigerating and Ice-making Machinery.
Feed Water Heaters.
Evaporators.
Fresh Water Distillers.
Main Feed Pumps.
Combined Circulating and Air Pumps.
Auxiliary Surface Condensers.
&c., &c. 1526

John Bellamy, Limited,
MILLWALL, LONDON, E. 1216
General Constructional Engineers,
Boilers, Tanks, & Mooring Buoys
Stills, Petrol Tanks, Air Receivers, Steel Chimneys, Riveted Steam and Ventilating Pipes, Hoppers, Special Work, Repairs of all kinds.

IRON & STEEL
Tubes and Fittings
AND
Steel Plates.
STEWARTS AND LLOYDS, Ltd.
GLASGOW BIRMINGHAM LONDON.
See Advertisement, page 56. 1111

Peter Brotherhood Ltd.,
PETERBOROUGH.
STEAM ENGINES AND TURBINES.
GAS AND OIL ENGINES.
AIR COMPRESSORS.
REFRIGERATING PLANT. 1475
See Advertisement, page 53, Dec. 21.

For Your Repairs or any
SPECIAL MACHINERY, try
THOMAS HUNT & SONS,
Albion Ironworks,
Bridge Road West, Battersea, S.W. 11.
Est. 1854. 1799

The Glasgow Railway Engineering Company,
GOVAN, GLASGOW. Ltd.,
London Office—12, Victoria Street, S.W.
Manufacturers of
RAILWAY CARRIAGE, WAGON & TRAMWAY WHEELS AND AXLES,
CARRIAGE & WAGON IRONWORK, also CAST-STEEL AXLE BOXES. 1234

HEAT INSULATION.
CELITE PRODUCTS CORPORATION,
Windsor House, Westminster, S.W.1. 1675
See our Illustrated Advertisement, Dec. 14.

MACHINE CUT
Gears.
Spurs, Bevels,
Spiral, Worm and
Worm Wheels.
HIGHFIELD GEAR CUTTING CO.
(Dept. H),
Huddersfield. 1645

Rosser and Russell, Ltd.,
Mechanical Engineers,
QUEEN'S WHARF, HAMMERSMITH, W.
Undertake SPECIAL MACHINE WORK of any description.
WELL EQUIPPED SHOP.
LATHE WORK up to 10 ft. diameter.
'Phone: Hammersmith 31, 967. 9211

James D. Roots — Patents,
BRITISH and FOREIGN. Moderate charges. Long and varied practical Engineering experience valuable to Inventors. Formerly many years contributor of Patents Abstracts for "The Engineer" & "The Times."—Thanet House, Temple Bar, London, W.C.2.

Machine Cut Gears
Spur and Spiral.
Worms and Worm Wheels.
Worm and Spur Reduction Sets.
High Grade Work at Reasonable Charges.
STORR & EVANS,
Grove Road, Hunslet, Leeds. 1673

Carels
Diesel & Steam
Engines.
1120
Carels Diesel & Steam Engines (London) Ltd.,
Kinnaird House, 1, Pall Mall East, S.W.1.
Telephone: Regent 3484.

Royles Limited,
ENGINEERS, IRLAM, MANCHESTER.
FEED WATER HEATERS, CALORIFIERS, EVAPORATORS, CONDENSERS, AIR HEATERS, } ROW'S PATENTS.
Merrill's Patent TWIN STRAINERS for Pump Suctions.
SYPHONIA STEAM TRAPS, REDUCING VALVES.
High-class GUNMETAL STEAM FITTINGS.
WATER SOFTENING and FILTERING. 5132

YARROW & CO. (1922), LTD., GLASGOW.
LAND AND MARINE
YARROW BOILERS. 1553

Matthew Paul & Co., Ltd.,
Levenford Works, Dumbarton. 1483
See Full Page Advt., page 57, Dec. 7.

Forgings.
Walter Somers, Limited, HALESOWEN. 7116

Taylor & Challen
Presses
For Production of SHEET METAL WORK, COINAGE, CARTRIDGES AND GUNPOWDER.
Foundry, Works, and Showrooms: BIRMINGHAM.
See advert., page 44, Dec. 7. 8195

Head, Wrightson & Co.,
LIMITED.
See Advertisement page 55. 2402

Railway
Switches and
Crossings.
T. SUMMERSON & SONS, LIMITED, DARLINGTON. 1312

DAVID BROWN & SONS (Hudd.) Ltd.
Lockwood Huddersfield.
HIGH CLASS
Machine Cut Gearing
FOR EVERY PURPOSE. 1440

Patents and Trademarks:—
Inventors Advice, Handbook and Consultations free.—KINGS PATENT AGENCY, LTD. (P. T. King, Director), 146a, Queen Victoria Street, London. 36 years' refs. 1209

Electric Cranes.
Traversers.
Transporters.
Lifts.
S. H. HEYWOOD & Co., Ltd.,
Reddish. 1357

Centrifugals.
Pott, Cassels & Williamson,
MOTHERWELL, SCOTLAND.
1676
See half-page Advertisement, page 88, Dec. 21.

## The Manchester Steam Users' ASSOCIATION.

For the prevention of Steam Boiler Explosions and for the attainment of Economy in the Application of Steam. 9, MOUNT STREET, MANCHESTER.

Chief Engineer: C. B. STROMEYER, M.I.C.E.

Founded 1854 by Sir WILLIAM FAIRBAIRN.

Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers inspected during construction. 1311

## Crystal Palace School of PRACTICAL ENGINEERING.

Founded 1872.

Principal.—J. W. WILSON, M.Inst.C.E., M.I.Mech.E. C 450

The New Course will commence on January 9th.

## Correspondence Courses for

Inst.Civil Engrs., Inst.Mech.E., London Univ. (Matric., Inter., B.Sc.), and All ENGINEERING EXAMINATIONS personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours), Assoc. M.Inst.C.E., M.R.S.I., F.R.S.A., etc., Also Day Tuition in Office. Excellent results at all Exams. Courses may commence at any time, and all Students receive individual tuition.—For full particulars apply to 8/11, TRAFFORD CHAMBERS, 58, SOUTH JOHN STREET, LIVERPOOL. 1295

## Engineering Salesmanship

and SALES MANAGEMENT.—Write for brochure describing our special Course of training for posts of unlimited scope in this lucrative field.—DIRECTOR, Institute of Engineering Salesmanship, 323, Oxford Road, Manchester. 1733


### TENDERS.

GREAT NORTHERN RAILWAY (IRELAND).

The Directors are prepared to receive

## Tenders for Supply of :—

FIVE 58 ft. PASSENGER CARRIAGES.

Copies of the Specification, Drawings and Form of Tender may be obtained from the undersigned, on payment of One Guinea, which will be refunded on receipt of a *bona fide* Tender and return of the Drawings.

Tenders, made out on the forms supplied by the Company, should be delivered, under sealed cover endorsed "Tender for Passenger Coaches," not later than Ten a.m., on Tuesday, 15th January, 1924.

The Directors do not bind themselves to accept the lowest or any Tender.

J. B. STEPHENS,
Secretary.

Amiens Street Station,
Dublin, 22nd December, 1923. C 471

COUNTY OF LONDON.

SALE OF ELECTRICAL POWER STATION PLANT.

## Tenders are invited for the

PURCHASE and REMOVAL of ELECTRIC CABLES and WIRE, PUMPS, PIPING, and VALVES, BUNKERS, TANKS, FLUE, ECONOMISER and WEIGHBRIDGE.

The Plant may be inspected at the London United Electric Tramways Power Station, 74, High Road, Chiswick, between the hours of Ten a.m. and Four p.m. on any week-day, except Saturdays, from 1st to 11th January, 1924, both dates inclusive, by appointment with a representative of the London County Council.

Particulars and Form of Tender may be obtained from the General Manager, London County Council Tramways, Victoria Embankment, W.C.2.

No Tender will be considered if received at the County Hall, Westminster Bridge, S.E.1, after Four p.m. on Monday, 14th January, 1924.

The Council does not bind itself to accept the highest or any Tender.

JAMES BIRD,
Clerk of the London County Council.
C 465

STATE ELECTRICITY COMMISSION OF VICTORIA.
Melbourne,
VICTORIA,
AUSTRALIA.

## Tenders are Hereby

Invited for the SUPPLY, DELIVERY, etc., of the following for the Morwell Power Scheme.

Copies of Tender Form and Specification will be available upon application to:—

AGENT-GENERAL FOR VICTORIA,
Melbourne Place, Strand
London, W.C.2.

SPECIFICATION No. 24/4.—
4 ONLY 100 K.V.A. 25,400-6600 V. TRANSFORMERS, AND SPARES.

CHARGE:—10/- for the first two copies of Tender Form, Conditions of Contract and Specification complete. This charge will be returned on receipt of a *bona fide* Tender. A third copy and any further copies will be supplied for the sum of 5/- each. This charge is not returnable.

PRELIMINARY DEPOSIT:—A Preliminary Deposit of £10 is to be lodged with Tender.

The Specification may be inspected at the above-mentioned office.

The Commission does not bind itself to accept the lowest or any Tender.

Tenders on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than Five p.m., 11th February, 1924.

R. LIDDELOW,
Secretary. C 440

## The Director-General,

INDIA STORE DEPARTMENT, Branch No. 16, Belvedere Road, Lambeth, S.E.1, REQUIRES:

LOCOMOTIVE TANK ENGINES.

Tenders due on the 25th January, 1924.

Tender Forms obtainable from above. C 467

BENGAL-NAGPUR RAILWAY COMPANY LIMITED.

The Directors are prepared to receive

## Tenders for :—

3000 SPIRAL SPRINGS.

Specification and Form of Tender can be obtained at the Company's Offices, 133, Gresham House, Old Broad Street, London, E.C. 2, on or after 27th December, 1923.

A fee of 10s. will be charged for the Specification, which is NOT returnable.

Tenders must be submitted not later than NOON, on Thursday, 10th January, 1924.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
R. C. VOLKERS,
Secretary. C 469

KEIGHLEY CORPORATION.

SLADEN VALLEY WATERWORKS.

CONTRACT G.

IRONWORK FOR VALVE WELL, FILTER BEDS, ETC.

The Corporation invite

## Tenders for the Manufacture

of STEEL MANHOLE DOORS, WROUGHT IRON LADDERS, CAST IRON COVER PLATES, STRAINER GUIDE COLUMNS, GIRDERS, and other work required in connection with the construction of the VALVE WELL; FILTER BEDS, and STRAINING WELL, etc., for the LOWER LAITHE RESERVOIR WORKS.

Copies of Specification and Schedule of Prices, and a limited number of copies of the Drawings (to be returned within seven days), may be obtained from the Engineer, MR. M. RATCLIFFE BARNETT, M.Inst.C.E., Town Hall, Keighley, on and after Monday, December 31st, 1923.

Sealed Tenders, endorsed "Keighley Waterworks, Lower Laithe Reservoir—Contract G," addressed to the Chairman of the Waterworks Committee, must be delivered to the undersigned on or before the 16th of February, 1924.

The Corporation do not bind themselves to accept the lowest or any Tender.

SMITH TERRY,
Town Clerk.

Town Hall,
Keighley.
December 22nd, 1923. C 473

### APPOINTMENTS OPEN.

THE ROYAL SOCIETY.

ARMOURERS AND BRASIERS' COMPANY RESEARCH FELLOWSHIP IN METALLURGY.

The Secretaries of the Royal Society are prepared to receive

## Applications for the above

RESEARCH FELLOWSHIP.

Provided applicants of sufficient merit apply the successful candidate will be required to enter upon a course of research which must be connected with base metals and alloys, and preferentially those used in connection with the Ancient Crafts of the Company of Armourers and Brasiers. The research is to be carried out under the scheme approved by the Royal Society and the Armourers and Brasiers' Company. The appointment will be for two years in the first instance, but may be extended to five years.

The stipend will be £500 per annum, dating from the commencement of the research.

Applications must be received at the Royal Society not later than March 1st next. Applicants will be required to state their academic qualifications, the research work already carried out by them, and to give three references.

THE ROYAL SOCIETY,
Burlington House, W.1. C 419

## Wanted, College Graduate

for Experimental and Research Work on Radio Loud Speakers. One having experience with sound producing devices preferred. State age, qualifications and salary required.—Address, C 457, Offices of ENGINEERING.

## Wanted, Power Station

SUPERINTENDENT for North Midlands, age under 40. Thorough experience Stirling Boilers and Turbo Generators. No testimonials with application. Salary £360.—Address, C 422, Offices of ENGINEERING.

## Works Superintendent

REQUIRED by Engineers in Midlands, employing 300 hands manufacturing Sluice Valves, Water Meters, Plumbers' Brasswork, etc.

Must be experienced in modern shop practice and mass production methods and be accustomed to controlling men, fixing lay-out of machine tools, etc.

Salary £400.—Address, in confidence, with full particulars of age and experience, C 464, Offices of ENGINEERING.

## Head Rate Fixer Wanted

for Marine Engine Works, North East Coast. Previous experience in similar work and knowledge of Marine engine works practice essential.

Address, giving full particulars, references and salary, C 424, Offices of ENGINEERING.

## Engineering Estimator.—

WANTED for Marine Engineering Works, a COST ESTIMATOR. Applicants should be well accustomed dealing with both Admiralty and High Class Merchant Work of medium power, and must have previous experience in estimating, fixing dimensions, etc.—Address, stating age, experience, and salary required, C 470, Offices of ENGINEERING.

## The Royal Air Force

REQUIRES SKILLED FITTERS General (for training as Aero Engine Fitters), Fitters Driver Petrol, Electrical Fitters and Power Station tradesmen. Age limits:—Ex-Service men 18 to 30; Non-Ex-Service 18 to 26; highly skilled Fitters up to 35. Ex-N.C.O's up to 38 years (with rank according to trade ability). Pay from 24s. 6d. to 66s. 6d. per week, on enlistment, and all found. Allowance for wife and children to men 26 and over.—Write, stating age, or call:—INSPECTOR OF RECRUITING, R.A.F., 4, Henrietta Street, Covent Garden, W.C.2. B 759

## Wanted, Engineer for Foreign

Sales Department. Well educated, good practical and technical training, also selling experience. French and commercial experience abroad essential.—Apply, giving full particulars of age, experience and salary required, to HANS RENOLD LTD., Burnage Works, Didsbury, Manchester. C 462

## District Engineer Re-

QUIRED by the GOVERNMENT OF PALESTINE for the RAILWAY DEPARTMENT, for three years' service with prospect of permanency. Salary £E.550, rising by annual increments of £E.25 to £E.750 a year. Expatriation allowance of £E.50 a year, plus a variable cost of living allowance at present 5 per cent. based on fixed minimum pay of appointment, plus and additional amount of £E.27 a year. Free first-class passages. Candidates aged 30 to 35, preferably single, must have at least 10 years' experience on Home Railways, on maintenance and construction work. Should be an A.M.I.C.E.—Apply at once, in writing, stating age, whether married or single, and giving brief details of qualifications and experence, to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting at the top of application M/12484. C 460

COUNTY COUNCIL OF SURREY.

HIGHWAYS AND BRIDGES DEPARTMENT.

## Applications are Invited for

the APPOINTMENT of a SECOND ENGINEERING ASSISTANT at a salary of £250 per annum. Candidates must have had experience in surveying, levelling, preparation of Drawings and specifications, for road and bridge construction, and shall have passed the examination qualifying for Associate Membership of the Institution of Civil Engineers or hold the Testamur of the Institution of Municipal and County Engineers. Age not to exceed 40.

The appointment will be to the temporary staff, and will not be subject to the provisions of the Local Government Officers Superannuation Act, 1922. Applications in candidates' own handwriting accompanied by copies of three recent testimonials, should reach the undersigned by the 5th January, 1924.

W. P. ROBINSON, A.M.Inst.C.E.,
County Surveyor.

County Hall,
Kingston-on-Thames,
21st December, 1923. C 463

STATE RAILWAYS OF VICTORIA, AUSTRALIA.

ASSISTANT CHIEF ELECTRICAL ENGINEER.

## Applications are Invited

by the VICTORIAN RAILWAYS COMMISSIONERS for the above POSITION.

SALARY £1000 per annum.

Applicants must pass Medical Examination.

Applicants must be capable of successfully handling all engineering and operating matters connected with railways, electrified systems, preparing proposals, alterations and extensions; also erection and maintenance of electric power and lighting installations throughout Railways.

Applicants should give full name, age, place of birth, details of Engineering and Administrative qualifications and practical experience on electrical railways, with copies of references.

Applications, in sealed envelopes, marked "Application for position Assistant Chief Electrical Engineer," should be addressed to the SECRETARY, Victorian State Railways, Melbourne, Australia, direct, and must reach him, on or before 31st March, 1924.

On behalf of the Victorian Railways Commissioners,
JOHN McWHAE,
Agent-General for Victoria (Australia),
Victoria House,
Melbourne Place, C 468
Strand, London, W.C. 2.

## Wanted, Capable Draughts-

MAN, accustomed to high pressure hydraulic work.—Apply, by letter, stating age, experience and wage required, to THE HYDRAULIC ENGINEERING CO., LTD., Chester. C 421

## Carriage Draughtsman,

experienced in Carriage Work for Home and Colonial Railways. WAGON DRAUGHTSMAN, experienced in Wagon Work for Home and Colonial Railways. Give full particulars of experience, and state wages required.—Apply (marked "Draughtsman") to E. Y. PICKERING & CO., LTD., Railway Carriage and Wagon Works, Wishaw, Scotland. C 461

## Draughtsman (Senior)

required for Head Office Group of South Wales Collieries. Well versed in modern colliery practice and Generating Stations. Apply stating salary required.—Address, C 466, Offices of ENGINEERING.

### SITUATIONS WANTED.

## Sales Engineer, Young,

Experienced, at liberty early New Year, SEEKS OPENING with reputable firm.—Address, C 351, Offices of ENGINEERING.

### WORK WANTED.

## J. Kirkaldy, Limited,

WORKS:
BURNT MILL, ESSEX. 1742

We are organised to produce castings from 2 lbs. to 2 tons. Cast-iron, Semi-steel, and Non-ferrous castings. Coils of every description. Steel and Copper. Sheet Metal Work. Over 40 years' experience is at your service. Send your enquiries along

## Engineer, M.I.Mech.E., with

well-equipped Machine Shops is OPEN to CONSIDER any MANUFACTURING PROPOSITION involving Castings in any Metal, Forgings, Machining and Fitting.

Repairs or alterations to Plant.

Apply,
GEO. H. WHITEHOUSE,
Engineer,
Great Bridge, Staffs. C

### WANTED, &c.

## Representation.—Gentleman,

thoroughly trained engineer, holding first-class B.O.T. certificate, with sound connection in Scotland with Engineers and Shipbuilders, DESIRES additional AGENCIES.—Address, 266, WM. PORTEOUS & Co., Glasgow. C 474

## Motor Wagon Weighbridge

WANTED, in first-class condition. Please state maker's name, full particulars, lowest price.—Address, C 458, Offices of ENGINEERING.

## Rolls, Second-hand, Wanted;

10 to 12 ft. for bending Boiler Plates up to 1¼ in. thick, to open at one end.—Address, C 439, Offices of ENGINEERING.

### PARTNERSHIPS.

IF YOU ARE SEEKING

## A Partner or Partnership

or wish to Buy or Sell a BUSINESS or WORKS

Write:—

## Wheatley Kirk, Price & Co.

46, Watling Street, LONDON, E.C. 4.

ESTABLISHED OVER SEVENTY YEARS.

### PATENT AGENTS.

## Patents

DESIGNS AND TRADE MARKS IN ALL COUNTRIES.

## E. P. Alexander & Son,

CHARTERED PATENT AGENTS,
306, HIGH HOLBORN, LONDON, W.C.
(Established 1874.)
Telephone: Central 7434. Cd 553

### AUCTION SALES.

## Wheatley Kirk, Price & Co.

(Established 1850),

## Valuers

AND AUCTIONEERS OF 1114

ENGINEERING WORKS PLANT AND STOCK.

46, WATLING STREET, LONDON, E.C. 4.
16, ALBERT SQ. 26, COLLINGWOOD ST.
MANCHESTER. NEWCASTLE-ON-TYNE.
Telephones and Telegrams at each Address.

## G. H.

BY DIRECTION OF THE COMMISSIONERS OF HIS MAJESTY'S WORKS AND PUBLIC BUILDINGS.

IMPORTANT AUCTION SALE
at the
GOVERNMENT INSTRUCTIONAL FACTORY, MORDEN ROAD, WIMBLEDON, S.W.,
On TUESDAY, JANUARY 15th, 1924,
and following days as necessary, at Eleven a.m. precisely, Messrs.

## Bradshaw Brown & Co.

(Partners: Geo. Ernest Nye & Walter K. Meyers, F.A.I.), will SELL by PUBLIC AUCTION
in Lots, the Modern
ENGINEERS' MACHINE TOOLS,
FOUNDRY EQUIPMENT,
WOOD-WORKING PLANT
and
VALUABLE METALS,
including:

Straight and Gap Bed S.S. and S.C. Lathes from 6 in. to 10 in. Centres, No. 2a and No. 3 Becker Milling Machines, Three Horizontal Milling Machines, Horizontal Planer, High-Speed Slotting Machine, 9 in. Stroke, High-Speed Radial Drill, 37 in. Radius, and other Single and Two-Spindle Drilling Machines, Universal Grinder (Churchill), Le Blond Universal Tool and Cutter Grinder, Two Wood Turners' Lathes, 30 in. Band Saw, Saw Bench, Core Ovens, Foundry Boxes, Sand Mill and General Foundry Equipment, 3½ Tons of Copper and Tin Ingots, 6½ tons of Electrolytic Copper Plates, Several Watchmakers' Lathes and Mandrels.

Carpenters' and Joiners' Tools and General Stores. Miscellaneous Effects.

On View two days prior to and Mornings of Sale by production of Catalogue, to be obtained at the AUCTIONEERS' OFFICES, Billiter Square Buildings, London, E.C.3. Telephone: Avenue 164. C 456

## THE MOTOR SHIP "MARGRETIAN" WITH BEARDMORE-SPEEDWELL OIL ENGINE.

THE motor-ship Margretian is noteworthy as being the first vessel to be equipped with the new type of two-cycle oil engine designed by Messrs. William Beardmore and Co., Limited, for the propulsion of medium and low-powered cargo vessels. In such vessels the simplicity and the low first cost of the machinery are of primary importance, outweighing any slightly greater fuel economy which a more expensive installation might show. The development of the type of engine under consideration in no way affects the activity of the company in the manufacture of the Beardmore-Tosi standard marine Diesel engine, as the types are not competitive in any way. One is rather the complementary type to the other, and the manufacture of both enables Messrs. Beardmore to supply propelling machinery for motor ships of every class ranging from the largest vessels down to coasters, trawlers, tugs, &c.

The general appearance of the Margretian is shown in Fig. 1, subjoined, and the arrangement of her machinery will be clear from Figs. 2 to 6, on Plate XLVI. She is a twin screw cargo vessel, built to the

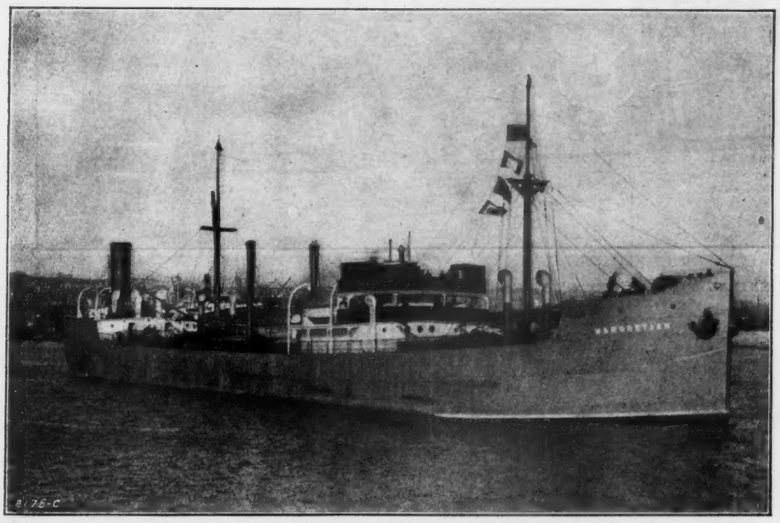


FIG. 1. THE "MARGRETIAN" LEAVING BARRY DOCKS.

order of Messrs. Watkin Williams and Co., Limited, of Cardiff, by Messrs. Charles Hill and Sons, Limited, of Bristol, under the supervision of Messrs. Thomas A. Reed of Cardiff. The Margretian is a vessel of the shelter-deck type, 310 ft. long by 43 ft. 6 in. in beam and 24 ft. 0½ in. deep to the upper deck, her deadweight capacity being 4,700 tons on a salt-water draught of 22 ft. 4½ in. She is built with a cruiser stern, and her machinery is fitted well aft, as shown in Figs. 2 and 5. The hull is divided by seven steel bulkheads, and five large hatches facilitate the rapid handling of cargo.

Double 6-ton derricks are fitted at each hatch, and at both the foremast and the mainmast there are also 20-ton derricks. The deck machinery consists of 10 steam winches, a windlass and a capstan, the exhausts from all engines being led back to a condenser on the engine room. Steam for cargo handling is supplied by the oil-fired Cochran boiler shown in Figs. 2 and 6. There is also a Spencer-Hopwood waste heat boiler which raises steam from the heat in the exhaust gases of the engines when at sea. This last named boiler is also fitted with oil-burning arrangements, the oil fuel system in the case of both boilers being supplied by the Wallsend Slipway and Engineering Company, Limited.

The accommodation for the captain and officers is arranged in the bridge, the crew being berthed aft. The vessel is fitted with electric light throughout, and wireless equipment is of course provided. There is also a well-fitted workshop, with lathe, drilling machine, &c., driven by a small steam engine. The Margretian normally carries 220 tons of fuel oil, and 41 tons of boiler oil, though a further 123 tons of oil can be carried, if desired, in the double-bottom tanks. The steam-driven oil transfer pump is so arranged that it can pump from, or to, any oil tank, or discharge the oil overboard should it at any time be necessary to empty all the tanks. There is no connection between the oil tanks and the water-ballast tanks, so that it is impossible for sea water to be run into the oil tanks, or oil into the ballast tanks. The oil tanks in the double bottom are fitted with steamcoils to ensure easy handling of the oil under all conditions of temperature.

The engine room is spacious and well arranged, with easy access to all auxiliaries, &c. The steam auxiliaries, condensing plant workshop, and lubricating oil storage tanks are accommodated in side galleries, the waste-heat boiler is on a platform between the side galleries aft, and the donkey boiler on a landing at the after end of the engine room. The steam-steering gear is fitted on the top of the aft peak tank, and, being open to the engine room, is therefore under the supervision of the engineer on watch. The vessel can also be steered from aft. The quantity of oil in the storage tanks is indicated by Pneumercator gauges in the chief engineer's room. The ballast pump and the oil-transfer pump, though normally steam-driven, are arranged to be worked by means of compressed air also, so that ballast bilges and oil can be pumped if no steam is available. The air for this purpose is furnished by a standby Reavell air-compressor driven by a 20-b.h.p. Beardmore engine.

The auxiliaries necessary at sea have been reduced to a minimum, as the main engines drive their own circulating and bilge pumps, the lubricating oil pumps and a fuel oil transfer pump. In addition to those we have mentioned is a steam-driven air compressor by Peter Brotherhood, Limited. It should be noted that, except as a standby for the auxiliaries, compressed air is only needed for starting and manoeuvring purposes, as the engines are of the solid injection type. The control station for the main engines is centrally situated on the bottom platform, all necessary levers and gauges being within easy reach, as will be seen from the illustration of the engine, Figs. 7, 8 and 9. The time taken in changing from full speed ahead to full speed astern was only about 5 seconds with the engines thoroughly warmed up.

Referring now to the engines themselves, which are illustrated in Figs. 7 and 8, on Plate XLVI, 9 to 11, on page 792, and 12 and 13, on page 793, these are, as has been stated, of the new Beardmore-Speedwell two-cycle type. Each engine has six cylinders, 18 in. bore by 24 in. stroke, and develops a rated power of 600 b.h.p. at 185 r.p.m. The overall length of each engine is 22 ft. 6 in., the maximum width 5 ft. 6 in., the height above the floor plates is 7 ft., and the weight, complete with flywheel silencer and exhaust pipes, about 45 tons. The simplicity of the engine renders any elaborate description needless. There are no valves to the cylinder, the latter being scavenged and charged with air compressed in the crank-case on the down stroke of the piston, which uncovers the exhaust and inlet ports at the proper moment. The port arrangement can be seen from Fig. 11. From this sectional view it will be noted that the cylinder heads are extremely simple castings, detachable from the cylinders at will. The shape of the combustion chamber, or the "hot-bulb" as it is frequently called, is the outcome of lengthy experimental work on the part of Messrs. Beardmore, and owing to its form it is claimed that the Speedwell engine will work with cheaper fuels even than the ordinary Diesel engine. It starts from cold without the use of blow lamps for preliminary heating and is extremely easy to manœuvre.

The ability to start easily is due partly to the fact that the engine works with a much higher compression than is usual in two-stroke engines, a feature which has the further advantage of reducing the weight of the engine in relation to its power and also of increasing its efficiency. In cold weather a hot water circulation is provided for the cylinders which gives the preliminary warmth so desirable for starting, and in addition electric starting plugs are fitted to ensure the firing of the initial charges. These plugs are put out of action when the engine is working. The engine can be relied on to fire evenly at low speeds on light loads, which is a most important feature.

Another feature which deserves special notice is the system of forced lubrication by means of which oil is fed under pressure to every bearing of the engine. The pump supplies the oil first to the main bearings, whence it passes through the shaft to the crank-pin, and thence up the connecting rod to the gudgeon-pin. The return oil is led to a settling tank where it is filtered and cooled before re-entering the circuit. The pistons are lubricated by mechanical sight-feed lubricators actuated by the engine. The fuel is injected into the cylinders by means of a pump so that the high-pressure air compressor used with the standard Diesel engine is not required. Each cylinder is provided with a separate pump, fitted with lightly-loaded automatic suction and delivery valves, each pump being operated by an eccentric working in phase with the crank of the corresponding cylinder. This eccentric drives a striker arrangement which causes the pump to deliver the fuel charge at and during the required period of injection. The fuel is sprayed into the cylinder through an automatic spring-loaded needle valve atomiser. This valve is opened by the pump pressure, thus dispensing with the ordinary fuel valve opening mechanism. The pump stroke is varied to suit the load and is regulated so as to deliver at each stroke, the exact amount of fuel required for the power being developed.

With such an arrangement there is little possibility of the oil entering the cylinder at the wrong time, even should the atomiser valve stick, or its frame break. Moreover, since the pump eccentrics are in line with the cranks, the engine operates equally well in either direction. Reversing is thus merely a matter of causing the engine to run in the other direction, and special astern mechanism is not required. Starting and manœuvring are carried out by means of compressed air. The air, which is provided by a separately-driven compressor, passes to a central distributing box and is delivered thence to the cylinders through mechanically-operated valves. Automatic non-return valves are fitted in the air pipes at each cylinder. When once the air has caused the engine to rotate in the required direction, the fuel is automatically injected at the correct time, and as soon as firing commences the air valves are thrown out of action.

The waste-heat boiler has already been referred to. The use of boilers of this kind in conjunction with internal combustion engines is a great source of economy provided that there is any use for the steam or hot water which they will furnish. The waste heat boiler moreover, forms an effective silencer. The utilisation of the heat in the exhaust

# BEARDMORE-SPEEDWELL OIL ENGINES FOR THE MOTOR-SHIP "MARGRETIAN."

CONSTRUCTED BY MESSRS. WILLIAM BEARDMORE AND CO., LIMITED, ENGINEERS, COATBRIDGE.

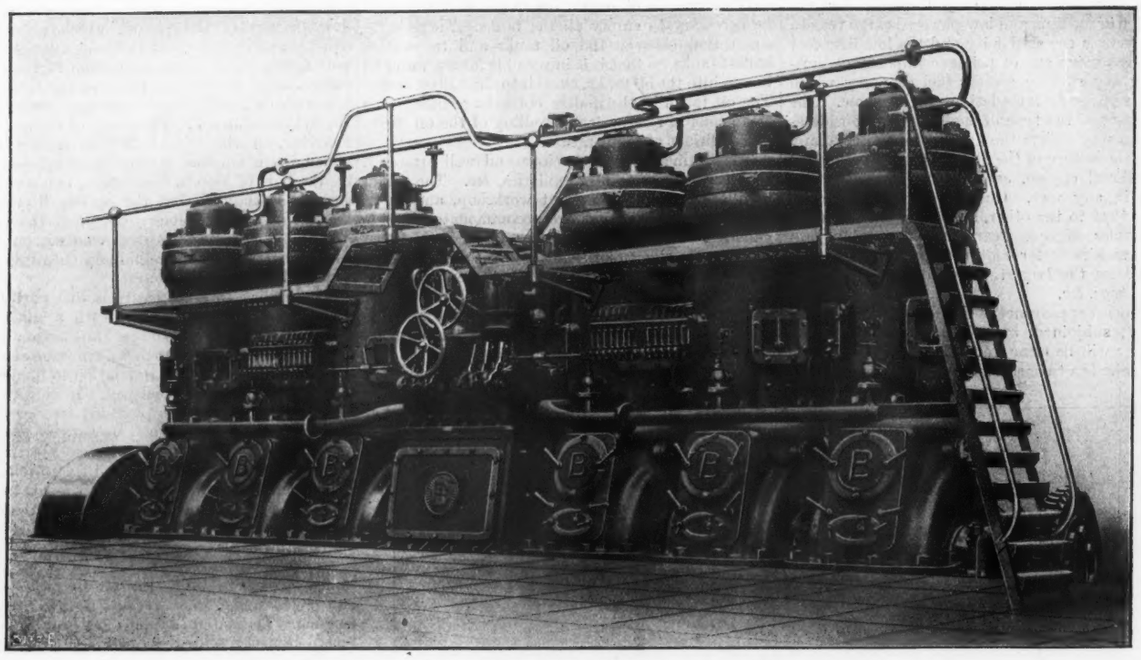
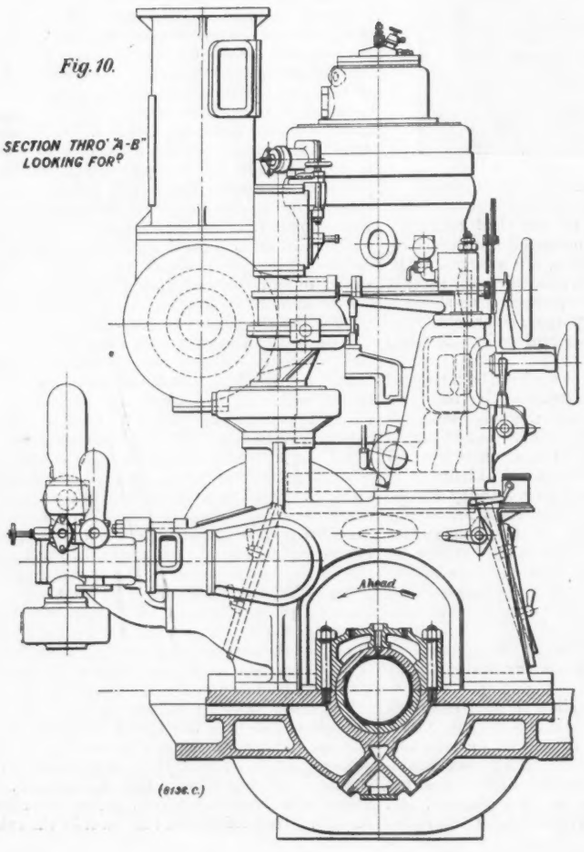
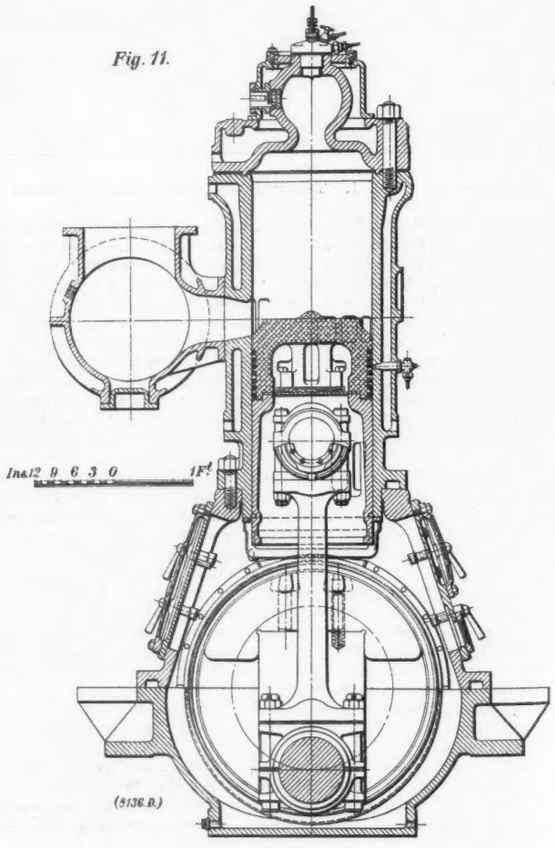


Fig. 9. General View of One of the 600-B.H.P. Engines.



# BEARDMORE-SPEEDWELL ENGINES.

CONSTRUCTED BY MESSRS. WILLIAM BEARDMORE AND CO., LTD., ENGINEERS, COATBRIDGE.

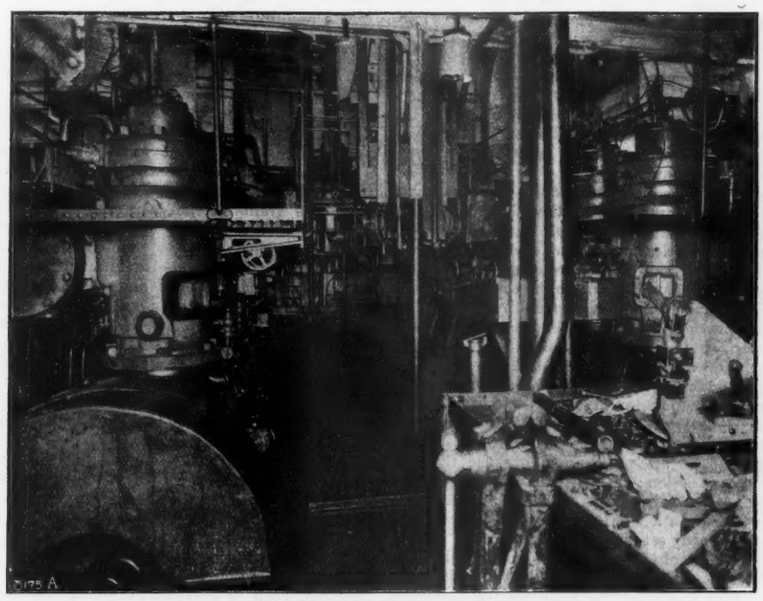


FIG. 12. ENGINE-ROOM LOOKING FORWARD.

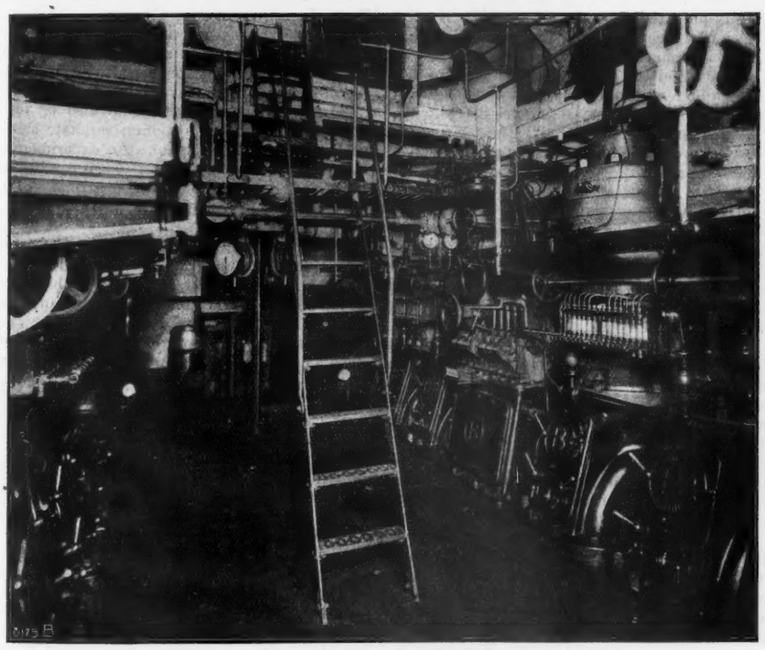


FIG. 13. ENGINE-ROOM LOOKING AFT.

gases of internal-combustion engines has been advocated for many years by Messrs. Beardmore and Co., and an illustration of such a boiler attached to a large gas engine built by the firm is to be found in a paper on large gas engines read before the Manchester Association of Engineers so long ago as 1911, by Mr. A. E. L. Chorlton.

In another paper, read in November last year before the North-East Coast Institution of Engineers and Shipbuilders, the same author estimates that about 1·58 lb. of steam can be produced from the waste heat in the exhaust gases of an oil engine for every brake horse-power-hour developed by the engine. A waste-heat boiler in a motor ship should be able to supply all the steam required on the voyage for heating, for the steering engine, &c., and it is fully expected that the boiler on the Margretian will do this. Auxiliary oil-firing arrangements enable extra steam to be raised, should the exhaust gases prove insufficient at any time.

The Margretian ran her trials in the Bristol Channel on November 15 last, attaining a speed of 11 knots under full load conditions. The engines behaved satisfactorily in every way and the vessel left straight for Genoa loaded with coal, the numerous guests who witnessed the trials being taken back to port by a tug.

# THE SCIENTIFIC AND INDUSTRIAL RESEARCH DEPARTMENT 1922–23.

(*Concluded from page* 741.)

*Radio Research Board.*—The Radio Research Board maintains close touch with the fighting services, the Post Office and the International Union for Scientific Radio-Telegraphy.

The work at the National Physical Laboratory on the design of an apparatus for measuring electric field strengths of received signals has led to a pattern being completed and set to work, careful observations being carried out on behalf of the International Union, and the apparatus compared with that used by the Post Office for similar measurements. Four similar sets have been manufactured for use at various stations. Other methods for measuring field strength are being considered, and apparatus is being developed for use on shorter wave lengths and at longer distances. A standard wave meter on the multi-vibrator principle is also being developed, which is expected to have an accuracy of 1 in 10,000. In this connection a tuning fork with a frequency of 1,000 per second has been constructed out of "elinvar," and is found to have a temperature coefficient only about one-tenth of that of ordinary steel forks. Work has also been carried out on the development of thermal heaters and junctions for measuring radio frequency currents from 1 milli-ampere to about 1 ampere.

The instrumental difficulties of observing the form, frequency and intensity of atmospherics have been removed by the introduction of the Western Electric Company's low voltage cathode ray tube, and results obtained by the use of it with the co-operation of Dr. E. V. Appleton, of the Cavendish Laboratory, will probably have an important bearing on the question of elimination. Four sets of apparatus for recording atmospherics automatically have been constructed and will be installed at Aldershot and Lerwick and in Egypt and India, for continuing observations on the direction of arrival of atmospherics.

Results obtained with the various practicable systems for radio direction-finding by reception have been published (see ENGINEERING, p. 305, *ante*). In connection with further observations on errors of bearing to be made in high altitudes, where the long twilight may be expected to affect the results, a direction-finding installation is being erected at Lerwick. At the Board's experimental station at Slough a large number of experiments were made on the effect in direction finding of various screens for coils, aerials and receiving apparatus, and on the use of coils rotatable about a horizontal as well as a vertical axis. The transmitting station at the National Physical Laboratory has been completed, and a small transmitting set installed at Slough, and with a portable single-frame receiving set are being used to ascertain the accuracy of direction-finding bearings over short distances, up to 15 miles over-land. The National Physical Laboratory is engaged on investigating the errors of bearings with short waves of 450 metres and upwards. With the co-operation of the Great Eastern Railway Company directional observations have been carried out from the Company's vessels by simultaneous reception at Slough and at the Admiralty station at Oxford.

A sub-committee is considering the question of amplifiers, and the National Physical Laboratory is developing a method for the accurate measurement of amplification and studying several problems relating to the functionirg of amplifiers. It is also investigating the use of forced-life tests as a means of testing the life of valves, considering the possibility of an all-metal transmitting valve, and determining the extent to which a high vacuum can be maintained in a phosphor bronze tube heated in an electric furnace.

The report gives indications of some of the results obtained from the considerable use that has been made of the Board's facilities. In practically all cases the work is still in progress, and reference for its details should be made to the original papers, where they have been published.

The Board has continued to publish abstracts of papers on radio-telegraphy published in the scientific and technical press, which appear to have been of value to wireless workers generally.

*Fabrics Co-ordinating Research Committee.*—The

Fabrics Research Committee has been engaged mainly on studying the deterioration of fabrics by micro-organisms, light and other agencies, and the testing of the strength of fabrics and of their resistance to water. It has now been arranged that samples will be exposed in various tropical climates under the supervision of competent mycologists, and after a considerable time of exposure will be sent for examination by Dr. A. C. Thaysen at the Royal Naval Cordite Factory. Meanwhile, the decay of certain fabrics is being investigated bacteriologically and by a swelling test, which distinguishes between chemical and bacterial action. It has been shown, for instance, that the decay of certain web equipment can be explained by chemical action and not by bacterial action, as was at first suspected. The cause, on the other hand, of deteriorated fishing nets has been shown to be bacterial. At the Royal Aircraft Establishment and the National Physical Laboratory the influence of light is being investigated. The Committee is actively seeking more reliable methods of testing fabric materials for strength, and for this purpose is trying to standardise the conditions of test and to improve the design of testing machines. A sub-committee has now been formed on the strength-testing of fabrics, which, apart from means for testing the strength of yarns and fabrics, is to consider the possibility of devising a test or tests to simulate the treatment undergone by a fabric when worn as clothing.

On the subject of waterproofness the Committee has been collecting information in the trade and from the Admiralty, War Office and Air Ministry, and has ascertained the uses made in the services of different types of waterproofed fabrics. It is hoped that on this information it will be possible to devise tests to be applied according to the nature of the fabric and the treatment it receives in use.

*Adhesives Research Committee.*—Adhesives are perhaps typical of the substances that, used in almost all industries, are in a sense the business of none, and thus are peculiarly fit subjects for the attention of a Research Committee. Up to now the Adhesives Research Committee has concentrated its work on glue and gelatin to the exclusion of other adhesives; an exclusion that, it may be hoped, will not be permanent. Three main lines of work have been followed. The chemistry of commercial gelatin has been studied, both by fractional diffusion of the gel into water and examination of the separate fractions—a process sometimes involving the elaboration of a new technique of estimation—and by correlating the properties of gelatine with its chemical composition, as, for instance, in observing the effect of varying ash content on its properties, which has involved working out a method of obtaining large quantities of electrically neutral gelatin with only a small percentage of ash for study of fundamental properties. A second line of research has been opened at Bristol University under the direction of Professor J. W. McBain, dealing with the fundamental nature of adhesion, of which at present little or nothing is known, and promising results have already been obtained. Finally, the nature of the rupture of glued joints is being studied at the Royal Aircraft Establishment, with the object of arriving at some simple and easily-prepared test piece, in which the breaking load would be a direct measure of the strength of the glue itself in normal conditions of use, and individual results would vary as little as possible from the mean value.

*Oxygen Research Committee.*—The work of the Oxygen Committee is sufficiently described in their recently-published report on metal vacuum vessels. (*Cf.* Engineering, p. 501, *ante.*)

*Gas Cylinders Research Committee.*—The Gas Cylinders Committee has been engaged on problems of cylinders for transporting liquid gases, and in the criticism of alloy steels or other alloys for light cylinders. At the outset it was found that in available knowledge of the physical properties of "non-permanent" gases there were many discrepancies and many lacunæ on points of vital importance to the Committee's work. Investigations were accordingly undertaken at the National Physical Laboratory to control the uncertain data and determine those that were unknown. The necessary experimental plant has been designed and constructed, and the investigations are now in progress. Meanwhile, information has been collected from the trade on the corrosive effect, if any, of liquefied gas on cylinders, and the nature and quantity of impurities found commercially in the gases. Information has similarly been collected from steel and gas cylinder makers on the subject of alloy steels, and on the replies a number of experimental cylinders have been ordered for test, including some of duralumin to the Committee's specification. An investigation is also progressing at the National Physical Laboratory into the effect of repeated heat treatment of wrought iron and steel, with a view to the practice of periodically heat-treating certain types of gas cylinders.

*Lubrication Research Committee.*—The Lubrication Committee's work, done at the National Physical Laboratory, has consisted of investigations into boundary lubrication in engineering practice, changes in pressure and temperature of the oil film between journal and bearing near the seizing point, and lubrication of sliding surfaces by "Aquadag" in the presence of superheated steam. A method has been devised for determining the coefficients of friction of different surfaces under conditions of boundary lubrication up to 2,000 lb. per square inch, showing that Amonton's law applies to friction under those conditions. It is hoped that critical conditions for seizure, now obscure, will be discovered. Investigations are progressing into the theory of boundary friction; in particular into the falling friction after a lubricant has been applied, which may take from a few minutes to an hour or more before a steady set is reached, and into the lubricating properties of two chemical individual substances.

*Current Meters Committee.*—The Current Meters Committee was appointed to investigate the instruments and methods of river gauging likely to be of use in this country. A bibliography of works dealing with stream gauging and current measurement was prepared for it in 1920 by Mr. Westcott and has now been brought up to date, and, as available information on current meters was not sufficiently detailed, field experiments have been made on different types, and the influence of conditions of calibration has been investigated.

These experiments consisted in measuring discharges on two rivers at various stages of flow, and also of comparing the results of consecutive runs by different waters at the same point. Under normal conditions of flow all the meters tested proved able to give the mean velocity within 2 per cent., but under specially turbulent conditions one of them gave results as much as 15 per cent. high. Calibrations of the same instruments made in the channel at the Imperial College and the large tank at the National Physical Laboratory, though not yet fully worked out, tend to show that under normal conditions the two calibrations give identical results, a result of importance in view of some Continental experiments, which suggested that in small channels results tended to be unreliable at high velocities. In screw meters, which were also rated in oblique positions, the errors (low readings) in the tank were less than those in the channel. For low velocities of flow an American method, depending on an electrolytic phenomenon at an electrode or pair of electrodes immersed in the moving liquid, was found unsuitable, as electrolytic phenomena proved to be too unstable to give dependable results. Another method, due to Dr. E. H. B. Wade, of the Egyptian Public Works Ministry, is still under investigation. A report on the Committee's experiments was published in Engineering (vol. cxv, p. 66).

For medium or small rivers methods of procedure in gauging have been worked out that can be used without either boat or bridge.

The above results, derived from ordinary rivers flowing in their channels under natural conditions of slope, cannot be applied to mountain streams and canalised or ponded rivers. The rapidity with which mountain streams erode and deposit *débris* on their beds would make recalibration of each section necessary after each flood. It is therefore usual to measure such streams over a weir, and a summarised abstract is being prepared of the principal experiments on the flow of waters over weirs in view of a future hydrometric survey. For the measurement of the discharge of ponded or canalised rivers over a long period of time special experiments would probably have to be carried out for each individual stream. In the Committee's view such experiments would be of little advantage before a survey is begun, and generally it anticipates that it will shortly complete such work as can be undertaken usefully until a survey authority for the water resources of the country is constituted.

*Appendices.*—Appendices contain as usual particulars of the membership of the Department's research boards and committees, statistics of grants to individual research workers and students in training, lists of aided and industrial researches, and of publications by individuals arising out of the Department's grant, and a table giving the names of all industrial research associations whether in receipt of grants or not, with the names of their directors and secretaries and other information.

Another appendix gives some interesting information on developments in the organisation of research in India, Egypt and the Overseas Dominions.

In India a Bill promoted by the Indian Central Cotton Committee has been passed, under which the Committee is established as a permanent organisation with cottom research as its main object. One-third of its membership is official, representing the Government of India, the local Government and the Native States, and about two-thirds represent commercial organisations and the various branches of the cotton industry. It receives a "cess" of 4 annas (say, 4*d.*) per bale on all cotton consumed in Indian mills or exported for the first three years, and 2 annas per bale thereafter; the industry thus finding compulsorily its own research funds. Considerable attention is to be given to agricultural research, both in provincial departments and in a central institute, while technological cotton research will be conducted in Bombay.

Chemical research is being conducted at the Technological Institute, Cawnpore. It has there been shown recently that Indian natural soda deposits, which contain sodium sulphate, could be worked to yield enough soda ash to satisfy all Indian requirements and equal in quality to that now imported. Sulphuric acid could also be made on a small scale from the sodium sulphate associated with the natural carbonate. An experimental glue factory, making glue under tropical conditions, has been started by the Madras Department of Industries, and is said to be turning out glue of excellent quality.

In Canada the Honorary Advisory Council for Scientific and Industrial Research, in addition to its training and fellowship grants—which are said to have had a marked effect in stimulating scientific research within the Dominion—and to the researches by private investigators that it has assisted, has done a considerable amount of work by its Standing Associate Committee on mining and metallurgy, silver fox breeding, air research, flax, biological subjects, "physics and engineering physics," chemistry and food research. A Lignite Utilisation Board is working under contributions from the Provincial Governments of Saskatchewan and Manitoba.

The Australian National Research Council and the Commonwealth Institute of Science and Industry find that the Institute is prevented from discharging its statutory functions and that its sphere of usefulness is severely restricted by the smallness of the funds at its disposal. Nevertheless, it has a number of important and urgent problems under investigation in regard to agricultural and pastoral industries and forest and vegetable products. It is also carrying out or co-operating in researches in the manufacture of pottery from local raw materials, and on a carburettor that can be adjusted immediately to any change of fuel within very wide limits. The Commonwealth Government has approved a scheme for establishing the Commonwealth Engineering Standards Association subject to the necessary funds being available. The reason for setting up an institution whose work must be closely parallel to; or identical with, that of the similar British body is not clear, having regard to the numerous local problems of which the investigation is said to be requiring more funds than are available or likely to be forthcoming.

Measures in South Africa have consisted mainly

# DETAILS OF 250-TON DRAGLINE EXCAVATOR.

CONSTRUCTED BY MESSRS. RUSTON AND HORNSBY, LIMITED, ENGINEERS, LINCOLN.

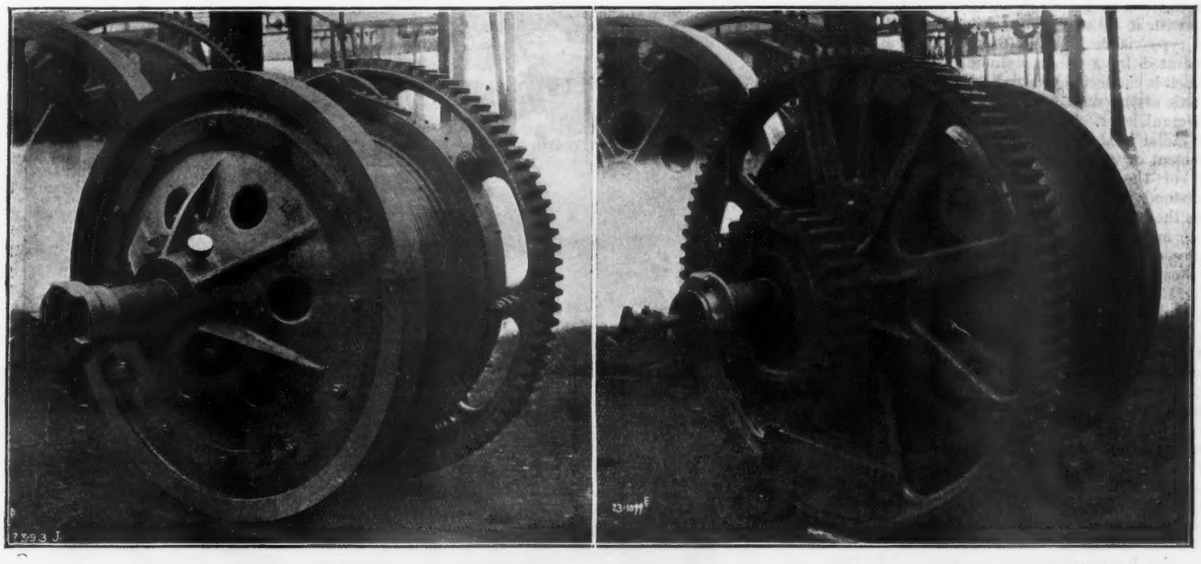


FIG. 19. FIG. 20.

FIGS. 19 AND 20. HOISTING DRUM AND DRIVING GEAR.

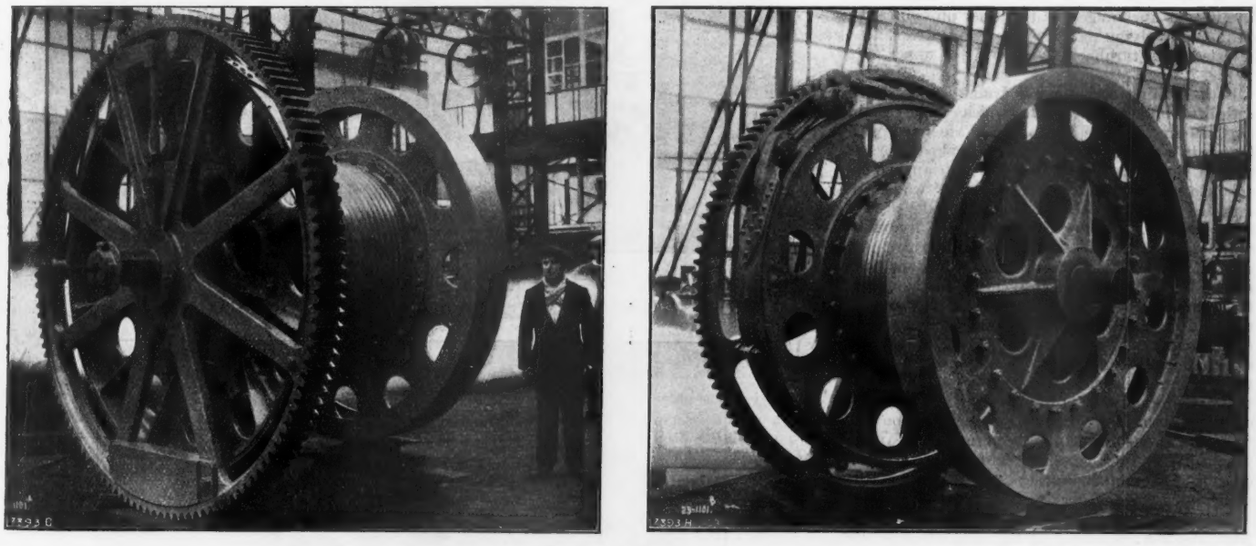


FIG. 21. FIG. 22.

FIGS. 21 AND 22. DIGGING DRUM AND DRIVING GEAR.

in reorganisations made on the recommendation of the Advisory Board of Science and Industry, which has now been dissolved, the financial stringency restricting actual research work within very narrow limits.

In New Zealand local lignites have been submitted to low-temperature carbonisation, and furnish yields of oil which, though not payable in themselves, would open up a considerable industry if the residues after distillation were made marketable, for example, by briquetting, and a suitable experimental press is to be purchased.

Research in Egypt is being conducted by the Egyptian Survey, the Physical Department of the Ministry of Public Works (including the Heliwan Observatory with its time service, the services of meteorology and weights and measures, and the hydrological investigations on the Nile), the Government analytical laboratory (at present mostly engaged on petroleum questions), the Public Health Department, the Cotton Research Board (working in the scientific institutes of the Ministry of Agriculture), and the veterinary pathological laboratory, the Serum Institute providing anti-cattle plague serum. The geological survey has already led to the commercial utilisation of Egyptian phosphate deposits and of the Sinai manganese deposits, and has already done work on petroleum research in the Red Sea area.

*France.*—An appendix gives the text of the Law creating the National Office of Scientific and Industrial Researches and of Inventions, as well as of the decree regulating its organisation and working. The scope of this body is similar to that of the British Research Department, but its mechanism is different in several ways, notably in the institution of a National Council of 145 persons who, under the presidency of the Minister, discharge important functions, including the election of the Administrative Council, which in effect is the executive authority, subject to the National Council and the Minister. Only 30 of the 145 members of the National Council represent industrial groups, 12 represent workmen's groups, 5 agricultural groups, 1 chambers of commerce, 29 various State departments, while the remainder represent the Senate, the Chamber of Deputies, the Council d'Etat, and 28 academic and educational bodies and learned and professional societies.

## 250-TON DRAGLINE EXCAVATOR.

(*Concluded from page* 765.)

To follow the general arrangement of the machinery of the excavator reference should be made to the side elevation given in Fig. 6, on Plate XLIV of our issue of last week, and to the

photographic illustration, Fig. 15, on Plate XLV of that issue. The hoisting drum, which we illustrate in Figs. 19 and 20, page 795, is driven from the crankshaft of the main engine by the pinion clearly shown in Fig. 18, on page 765 *ante*. Actually the drum is loose on the shaft, but is put into engagement with it by means of a friction clutch of the band type visible in Figs. 19 and 20. This clutch is operated by a steam cylinder, the piston rod of which is connected to a rod which passes through the axis of the shaft and is coupled to the end of a bell crank lever. The latter is connected by means of a radial link to a second bell-crank lever, the movement of which tightens up or slackens off the band of the clutch. The arrangement will be understood on reference to Fig. 20, which also shows the balance weight bolted between the spokes of the spur wheel to compensate for the out-of-balance effect of the clutch-operating mechanism. The steam cylinder operating the gear can be seen in Fig. 15, on Plate XLV, previously referred to.

A pinion on the hoisting drum shaft, shown in Fig. 20, drives the digging drum, the arrangement of which is generally similar to that of the hoisting drum, but on a larger scale. Two views of the digging drum are reproduced in Figs. 21 and 22, on page 795, and the man visible on the right-hand side of the former gives a good idea of the dimensions of this component. The drum, we may mention, is 4 ft. 4¼ in. in diameter at the bottoms of the grooves, and the pitch diameter of the spur wheel is 9 ft. 4·044 in. The drum is driven by a band clutch in a manner similar to that described in connection with the hoisting drum, but the diameter of the clutch race of the digging drum is 7 ft. 10 in. In both cases the clutch bands are of spring steel lined with Ferodo fibre, the lining being secured by bolts so that it can easily be renewed. Mild steel palms are fitted to the ends of the bands, one forming the anchorage and the other providing the means for applying the tension. The clutch can be adjusted by a turnbuckle visible in the upper part of Fig. 22.

Both hoisting and digging drums are provided with band brakes, the races for which can be seen in Figs. 19 to 22. The brake bands are lined with Ferodo in a similar manner to that employed for the friction clutches. The brakes are each applied by separate steam cylinders, the valves of which are actuated by foot pedals. The steam brake pistons are, however, directly connected to hydraulic cylinders, and the steam and hydraulic valves are also interconnected so that when the pistons have moved by an amount corresponding to the extent to which the pedal has been depressed, they come to rest and are held in that position. This arrangement, which we illustrate in Fig. 23, annexed, is commonly employed in connection with mechanism of this class, as it enables the brakes to be applied easily and gradually and to be held in any intermediate position between full on and full off that the driver may require. The leverage provided has been carefully proportioned to give efficient control of the bucket during the operations of swinging out and discharging.

The travelling motion, already described on page 765 *ante*, is driven off the spur wheel of the digging drum through a pinion and a pair of mitre wheels which can be distinguished in Fig. 6, on Plate XLIV, published with our issue of last week. A separate engine mounted at the front end of the revolving frame drives the slewing motion, the position of the engine being clearly shown in Fig. 6, while the engine itself is illustrated in Fig. 24 on the present page. The engine has two simple cylinders, each 11 in. in diameter, with a piston stroke of 10 in. Steam is distributed by slide valves of special design, but reversing is effected by means of a piston valve included in the steam chest, the piston valve also acting as a throttle valve so that the driver can control the engine completely by the movement of a single lever. The engine drives a vertical shaft through spur and bevel reduction gear, as will be understood on reference to Fig. 24, and a pinion mounted on the lower end of the vertical shaft engages with a circular rack carried on the fixed frame of the machine. A slipping clutch is provided on this gear to protect it from overloading by improper operation of the machine. The rack and pinion of the slewing gear

# DETAILS OF 250-TON DRAGLINE EXCAVATOR.

CONSTRUCTED BY MESSRS. RUSTON AND HORNSBY, LIMITED, ENGINEERS, LINCOLN.

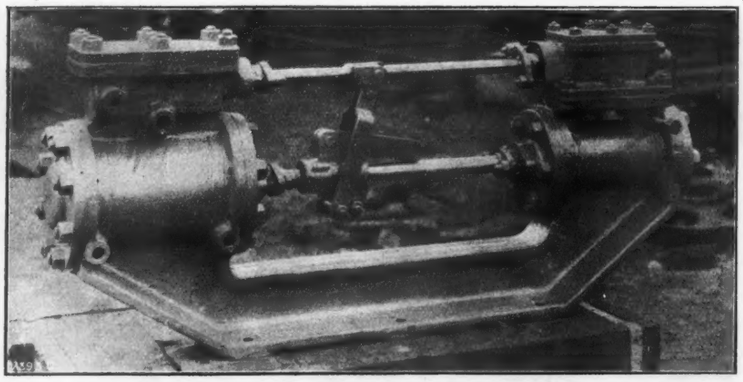


Fig. 23. Steam Brake Gear.

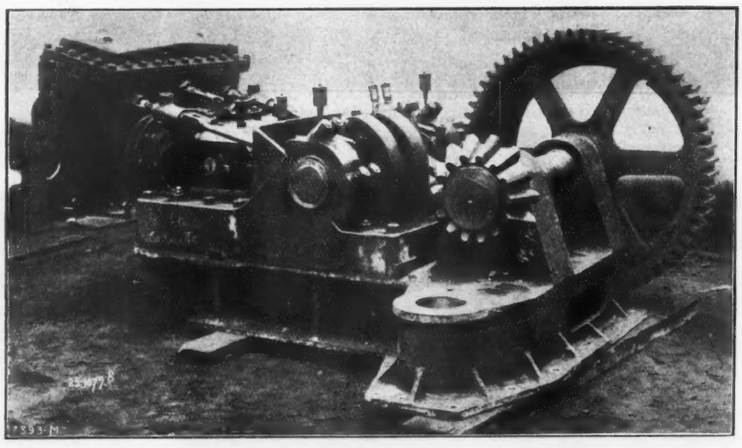


Fig. 24. Steam Slewing Engine.

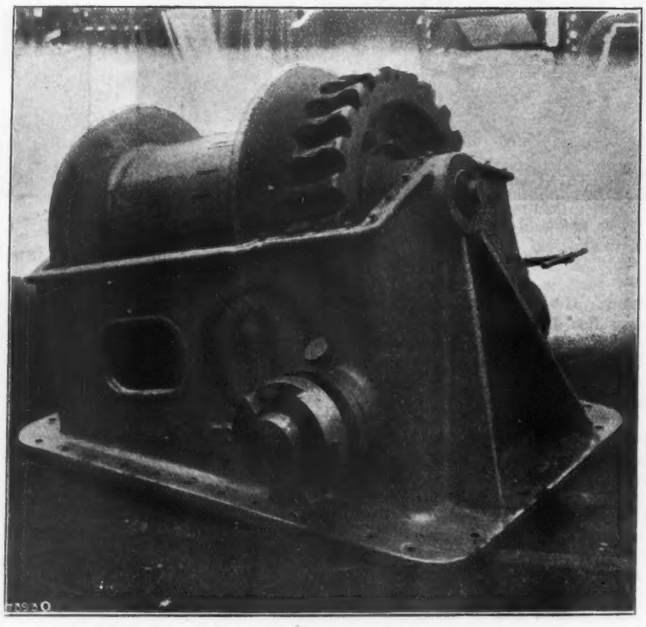
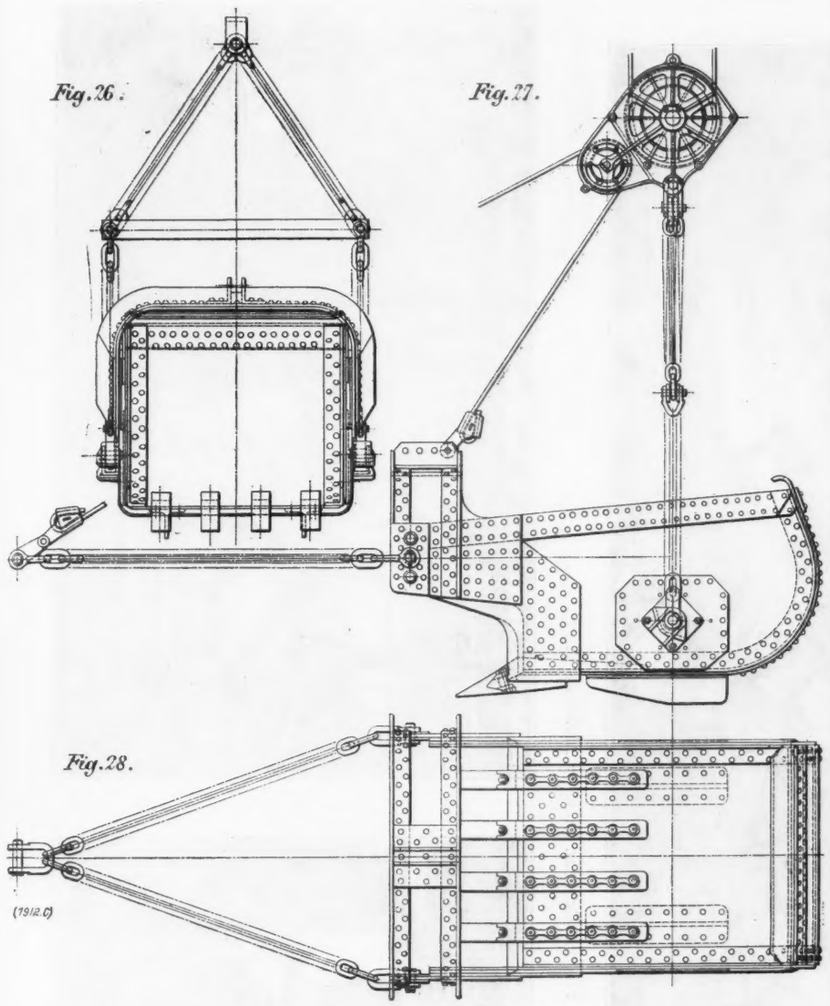


Fig. 25. Derricking Gear.

# BUCKET FOR 250-TON DRAGLINE EXCAVATOR.

CONSTRUCTED BY MESSRS. RUSTON AND HORNSBY, LIMITED, ENGINEERS, LINCOLN.




FIGS. 26 TO 28. DETAILS OF DRAG BUCKET.

have moulded teeth, but all other gears have teeth cut from the solid.

The only other detail of the machinery that need be referred to is the derricking gear, which is illustrated in Fig. 25, on page 796. The rope drum of this gear is driven by worm gearing from the shaft of the hoisting drum, the jaw clutch by means of which the worm shaft is connected to the hoisting drum shaft being clearly shown in Fig. 25, while the corresponding part of the clutch can be seen on the left of Fig. 19, on page 795. The general arrangement of the gear is best shown in Fig. 6, on Plate XLIV *ante*, and it will be clear from this illustration that the drum has been set on an angle with the horizontal in order to bring the axis of the drum at right angles to the direction of the derricking rope.

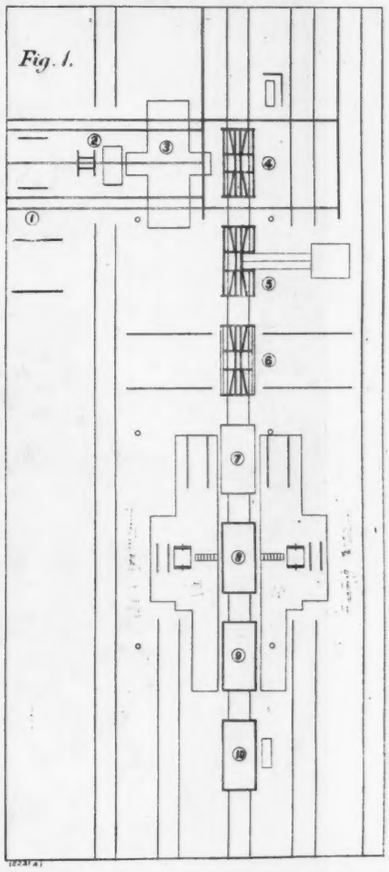
Drawings of the bucket are reproduced in Figs. 26, 27 and 28, annexed, these figures giving front and side elevations and a plan, respectively. The bucket, as previously mentioned, has a capacity of from 7 cub. yards to 8 cub. yards, and it is constructed of mild-steel plates strongly riveted as shown. It is fitted with a renewable lip plate and with four digging prongs of cast steel, the wearing points of which can also be easily replaced. The arrangement of the digging and hoisting ropes and the method of attaching them to the bucket can be followed from the illustrations. The trunnion brackets for the hoisting ropes, we may mention, are of cast steel, and it should also be pointed out that holes at different heights are provided on each side of the bucket for the attachment of the chains connected with the digging rope. This arrangement enables the "bite" of the bucket to be varied to suit the nature of the ground being excavated.

In conclusion, we may mention that particular attention has been given to the lubrication of all moving parts, mechanical lubricators being provided on both the main and slewing engines. All the wire ropes employed are of specially flexible six-strand construction, having 37 wires to each strand, the wire being of special improved plough steel. Finally it may be stated that the materials and workmanship employed in the construction of the machine are of the best possible quality throughout, this being essential to ensure efficient and reliable operation under the arduous conditions to which the machine is necessarily exposed in service.

## THE MASS PRODUCTION OF RAILWAY WAGONS.

IN our issue of October 12 last we described the methods which have been introduced at the London Midland and Scottish Railway Company's works at Derby in connection with the building of railway carriages. These methods, which are due to Mr. R. W. Reid, the carriage and wagon superintendent, represent the adaptation of modern machine-shop practice to wood working. The various timber parts are machined to stops and gauges and pass through an inspection system exactly as in modern good-class repetition work in metal, as for instance in the manufacture of motor-car engines. These methods, which have enormously facilitated erection and improved output by eliminating all necessity for hand fitting between the various parts, have now been extended to wagon building and through the courtesy of Mr. Reid we had an opportunity of seeing this latest development in operation at the Derby works on the 18th inst.

As a railway wagon is a simpler article than a railway coach and is required in larger quantities, the refinements of modern repetition methods may be more easily applied to its manufacture and the




building of wagons as now carried out at Derby approaches the systems which are in operation in connection with the manufacture and assembly of some of the more popular makes of motor car. Although we imagine Mr. Reid would not wish to suggest that his assembly methods do not owe much to the experience which has been made available in connection with motor-car building, it must none the less be recognised that the methods in operation at Derby are original as applied to railway rolling stock, and represent a development which is certain to be applied in other works in the future. The essential advance which has been made at Derby lies in the adaption of modern machine methods to woodwork. The whole of a wagon or railway carriage parts are finished to final size at the machines, and assembly becomes a mere putting together without the necessity for fitting of any kind or any sort of individual selection of parts. As we dealt very fully in our previous article with the machining processes which have made this procedure possible, we propose here mainly to concern ourselves with the matter of assembly, merely remarking that by a proper selection of tools, the fitting of special stops to the machines and the introduction of a complete gauging system the various wagon parts are delivered to the erection shop in such a state that they will go together like

# THE MASS PRODUCTION OF RAILWAY WAGONS AT THE L.M. AND S. RAILWAY WORKS, DERBY.

MR. R. W. REID, M.I.MECH.E., CARRIAGE AND WAGON SUPERINTENDENT.

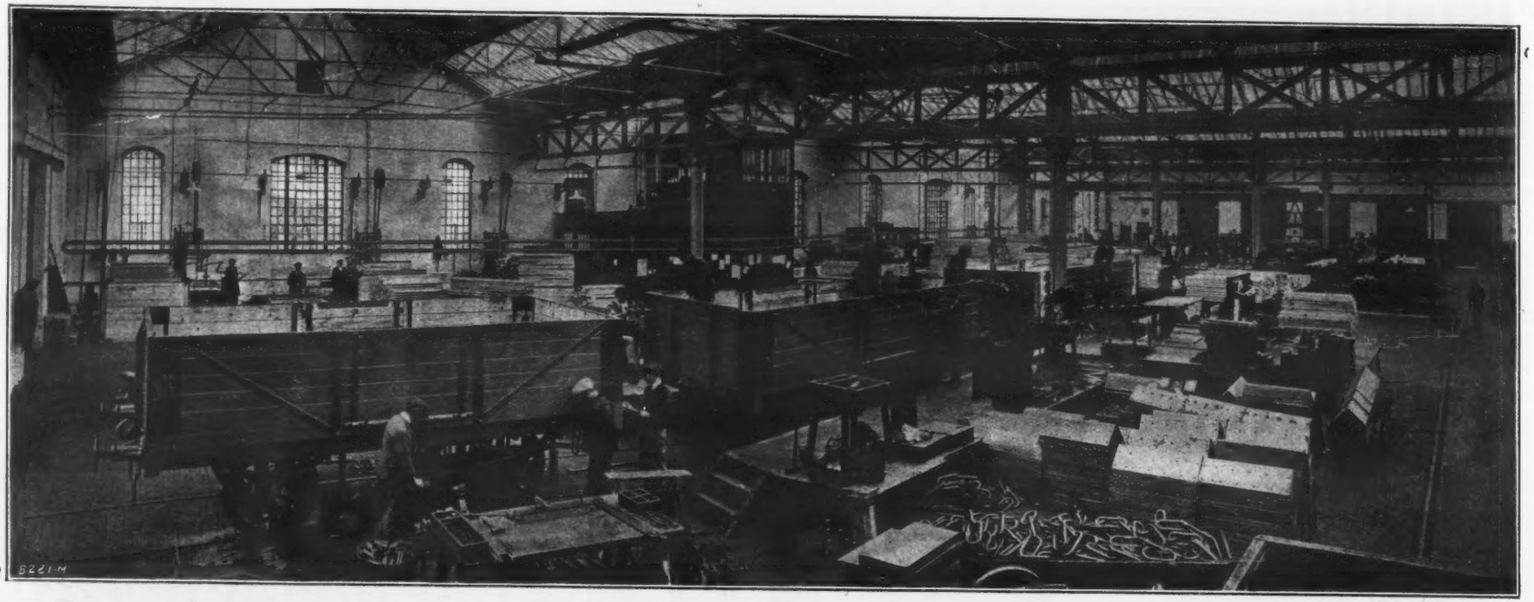


FIG. 2. GENERAL VIEW OF ASSEMBLY PLANT.

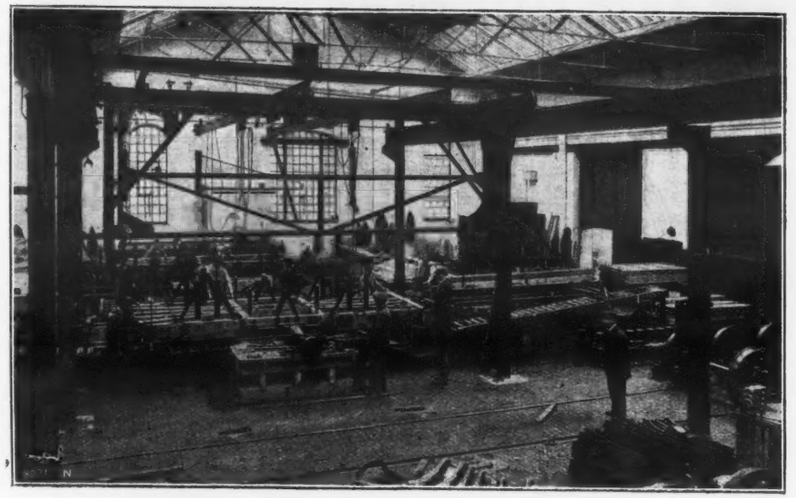


FIG. 3. ASSEMBLING UNDERFRAME.

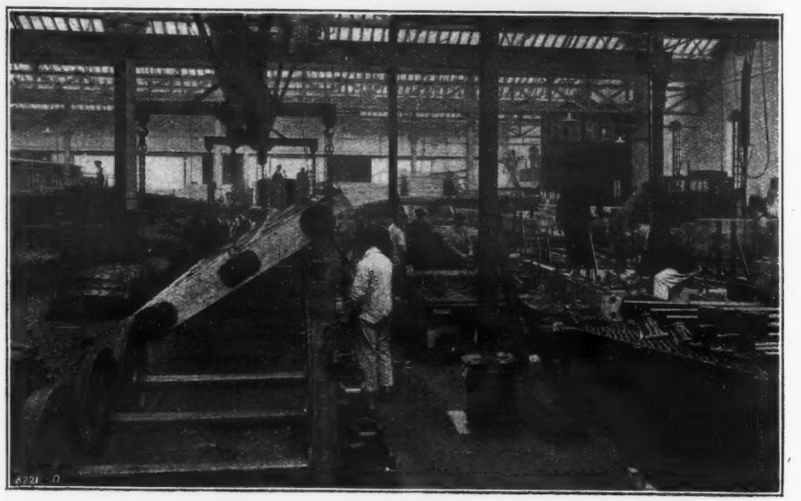


FIG. 4. REVERSING UNDERFRAME FOR WHEELING.

THE MASS PRODUCTION OF WAGONS AT THE L. M. AND S. RAILWAY WORKS, DERBY.

Fig. 3. Assembling Underframe.

Fig. 4. Reversing Underframe for Wheeling.



# THE MASS PRODUCTION OF WAGONS AT THE L. M. AND S. RAILWAY WORKS, DERBY.

MR. R. W. REID, M.I.MECH.E., CARRIAGE AND WAGON SUPERINTENDENT.

*Fig. 5.* OPERATION No. 1. LAYOUT FOR WAGON SOLEBARS.

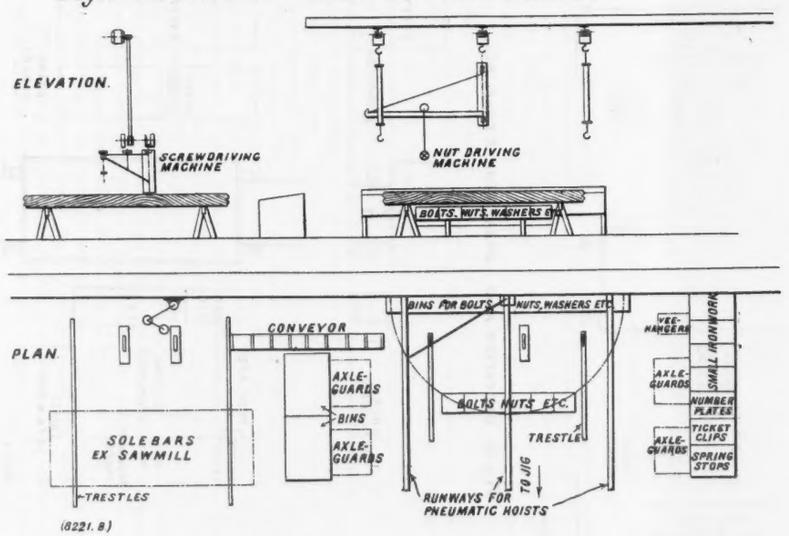



*Fig. 6.* OPERATION No. 2. LAYOUT FOR HEADSTOCKS, LONGITUDINALS & CROSSBARS.

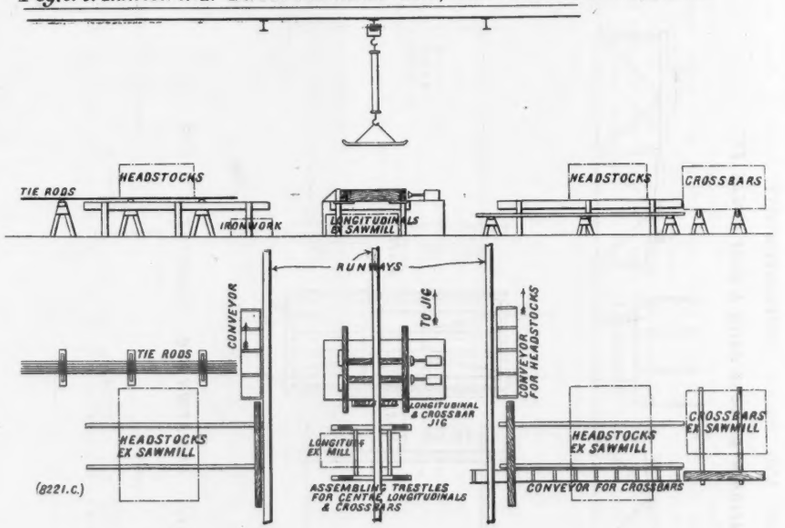



*Fig. 7.* OPERATION No. 3. ARRANGEMENT OF FRAME JIG &; ASSEMBLY OF UNDERFRAME

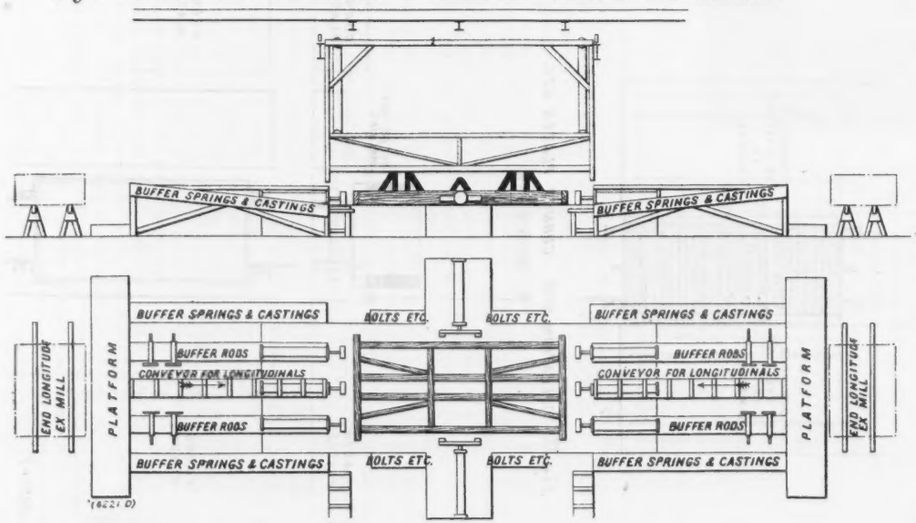
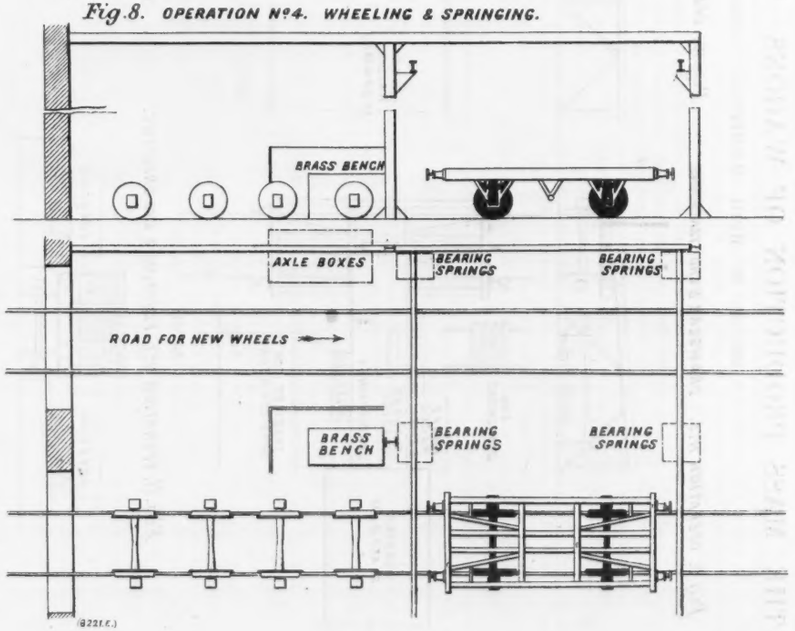



*Fig. 8.* OPERATION No. 4. WHEELING & SPRINGING.



# THE MASS PRODUCTION OF WAGONS; L. M. AND S. RAILWAY WORKS, DERBY.

MR. R. W. REID, M.I.MECH.E., CARRIAGE AND WAGON SUPERINTENDENT.

*Fig. 9.* OPERATION No. 5. DRAWGEAR & END STANCHIONS.

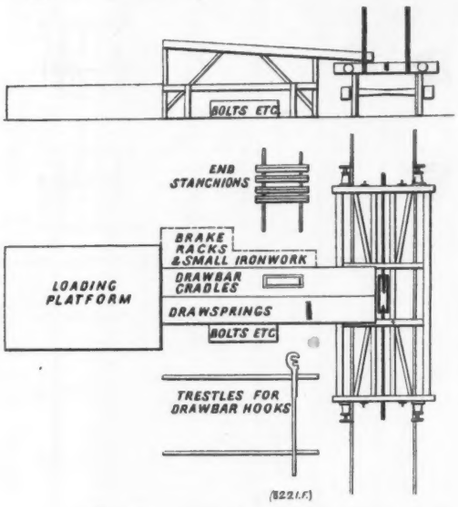



*Fig. 10.* OPERATION No. 6. CURB RAILS & BODY KNEES ETC.

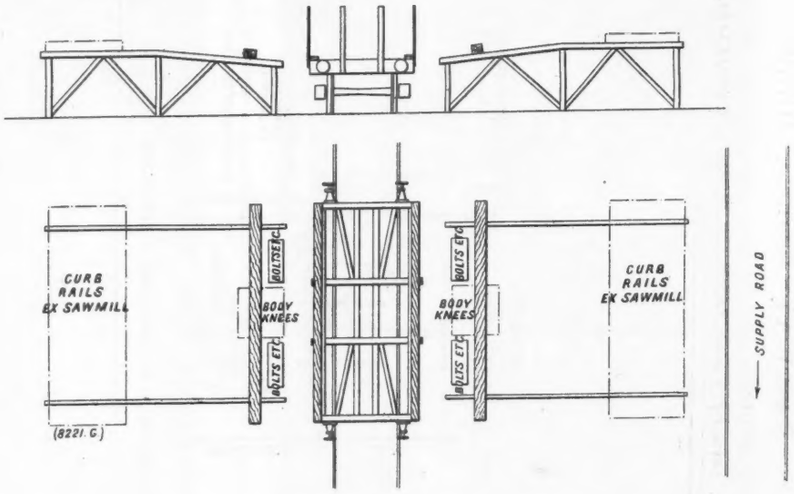



*Fig. 11.* OPERATION No. 7. FLOORING & END SHEETING.

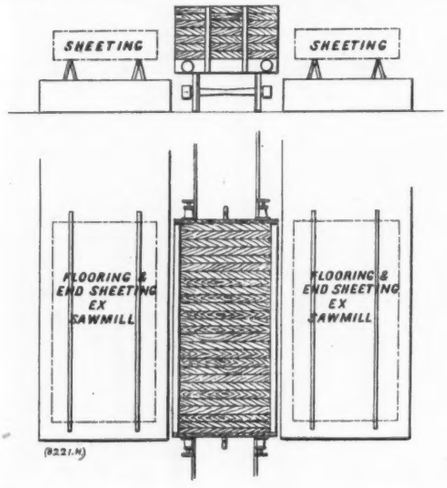



*Fig. 12.* OPERATION No. 8. QUARTERS & DOORS.

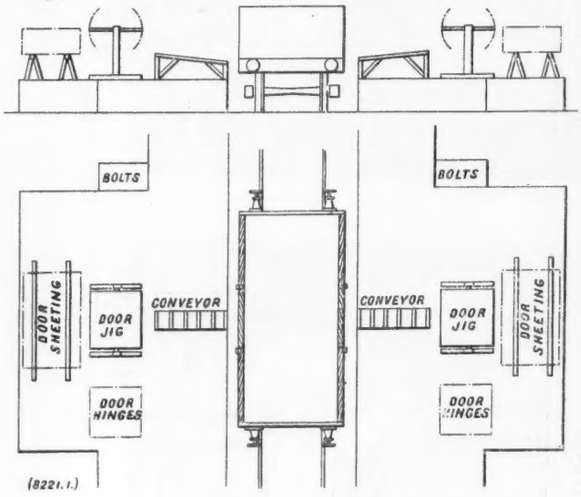



*Fig. 13.* OPERATION No. 9. CORNER PLATES ETC.

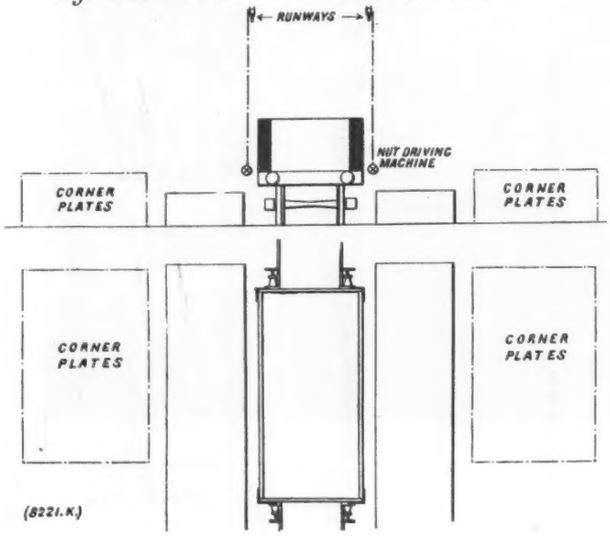
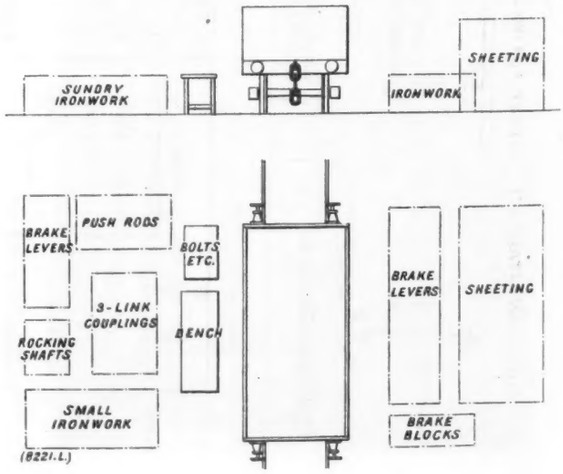



*Fig. 14.* OPERATION No. 10. BRAKEWORK & COUPLINGS.



the parts of a sewing machine. The common criticism that a procedure of this kind is not possible with timber members owing to the alteration in dimensions which is stated to take place after machining is found by experience to be baseless, and absolutely no difficulty has been found to arise from the nature of the material dealt with.

The wagon which is at present being built at Derby is the new 12-ton Railway Clearing House standard wagon. The present output is 87 wagons a week, and some 1,200 have been turned out from the new plant since it was put into operation. The shop in which the new mass assembly is being carried out was not built specially for the work, but it has lent itself well to the adoption of the scheme. A key plan of the assembly unit is given in Fig. 1 on page 797. The basis of the scheme is a division of work among the men who make up the total gang working on the assembly unit, so that each is continually engaged on the same job. The total assembly is divided up into a series of operations, each arranged to take approximately the same time, so that all operations start and are completed at about the same moment. Each operation is always carried out at the same point in the assembly unit, and when the whole of any particular batch of operations is completed the whole line of partly-erected wagons moves forward one stage, so that each comes into position to have the next operation performed on it, The operations are arranged to take about half an hour each, so that at the end of each half hour a completed wagon leaves at one end of the assembly unit and a new one is started at the other.

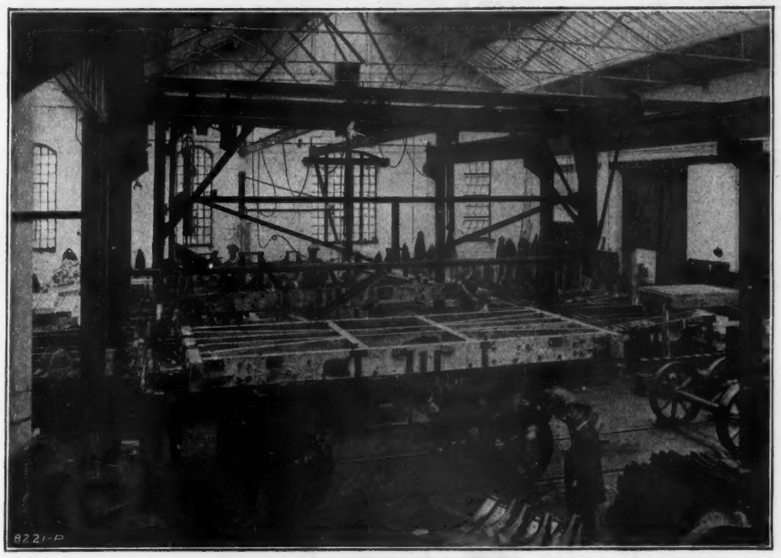


FIG. 15. ASSEMBLING WHEELS.

The erection of the wagons is divided into ten operations which are indicated by the numbers surrounded by small circles in Fig. 1, the numbers being placed in the position at which the various operations are carried out. This key plan, together with the general view of the assembly unit, which is given in Fig. 2, on page 798, clearly illustrates the passing forward of the gradually completed wagons from stage to stage. Views taken at two intermediate positions are given in Figs. 3 and 4, while on pages 799 and 800, in a series of diagrams, each operation is independently illustrated. A further view of one of the intermediate operations is given in Fig. 15, annexed. The early operations are concerned with the assembly of individual parts, and operation 1, diagrammatically illustrated in Fig. 5, covers the assembling of all ironwork such as axle-guards, vee hangars, diagonal knees, &c., on to the solebars. The solebars are drilled to jig for this work during the process of machining, and all parts are directly mounted in place without any drilling or marking-off. A double-geared pneumatic drill, carried from overhead by a small crane and fitted with a box spanner, is used for tightening up nuts. This appliance saves much time and labour. As will be seen, this operation is carried out alongside the upper end of the track on which the wagons are finally erected. The solebars, which are delivered from the machine shop on wagons, are unloaded on to trestles the correct height for a man working on them. When the solebars are completed they are pushed forward on a roller conveyer ready to pass to the men who assemble the complete underframe.

Operation 2, which, as will be understood from what has previously been said, is going on simultaneously with operation 1, covers the assembly of the middle bearers of the underframe. Its position is indicated in Fig. 1 and its details in Fig. 6. The middle bearers are pushed on to the tenons of the middle longitudinals by hydraulic rams, and the brake block hangers and safety loops are assembled as in the case of the ironwork of the solebars.

This main assembly, which is shown in Fig. 7, constitutes operation 3. It is illustrated by a general view in Fig. 3. The main assembly jig consists of a platform on which strips are fixed which locate the positions of the middle bearer, the longitudinals and solebars. In assembly the completed middle bearer, which, as will be seen from Fig. 1, is lying just alongside the main jig, is picked up by an air hoist and placed in position on the jig, being located by the strips already mentioned. The solebars are then lifted by two air hoists and placed in position, while the longitudinals and diagonals, which are in position on roller conveyors close alongside the jig, are pulled down and placed in position. These conveyors are on the longitudinal centre line of the jig.

With all the main parts in position on the jig, assembly commences. As will be seen from Fig 7, the jig is furnished with a series of hydraulic rams. The first operation is carried out by means of the side rams which come up and squeeze the solebars on to the middle bearer. The end rams are then operated, and by means of a false headstock, which is dropped between the rams and the end diagonals and longitudinals, these are closed home on the middle bearer. The longitudinal knee is then dropped in position and the diagonals bolted up to the diagonal knee. When this has been completed the headstocks are pushed across on their conveyors into position on the main jig and they are then squeezed home on to the solebars, diagonals and longitudinals by means of the end rams. This practically completes the building of the underframe. The axle-guards are then squared and the frame is lifted and placed on packing blocks. The buffer rods and buffing springs are then slipped off the conveyor into position and the frame is dropped back on to the table. The four corner rams are then operated to compress the buffing springs and allow the cotters and rebound rubbers to be placed in position. This compression of the buffing springs by the corner rams to enable the cotters to be put in place is one of the most striking items in the whole assembly, as it enables a job to be carried out in a few minutes which, under the old method of erection, took about an hour. It should be mentioned that in this, as in all other operations, the various bolts and other detail parts required are carried in boxes, or stacks, close to where they are required, so that no time is lost by the men going to fetch or looking for material. This main frame assembly is the biggest operation in the whole wagon erection, and determines the rate of output of finished wagons. Only a limited number of men can effectively work on the main jig, and this number determines the assembly time at half an hour. The number of men on other operations is accordingly arranged to make the time of each of them approximate to the same half hour.

Operation 4 (shown in Fig. 8) covers wheeling and springing. The main frame is left by operation 3 wrong way up, and it is lifted by putting a pair of trunnions through the drawbar holes in the headstocks. It is then carried by the crane to the first position on the wagon assembly track, as indicated in Fig. 1, and is turned over into the correct position for wheeling, as shown in Fig. 4. The frame is dropped on the floor and is then picked up by the crane by the four corners. This is done by means of four chains hung on the crane. The object of lifting by the corners is to keep the frame level and so facilitate wheeling. The two pairs of wheels and axles are then run down the track from the stock into position under the frame, as shown in Fig. 15. The springs are put in place and the weight is lowered on to the wheels. The wagon is then ready to pass forward to the next operation. From this point the wagon travels on its own wheels, and it will be clear that the latter part of the assembly gives the equivalent of a conveyor assembly system without the heavy capital cost that a wagon conveyor would represent.

The remaining operations, numbered 5 to 10, we do not propose to describe in detail, as the various stages in the erection with which they are concerned will be clearly followed from Figs. 9 to 14. At operation 5 the draw gear and end stanchions are fixed in place, and the wagon then passes on to operation 6, in which the curb rails, body knees, &c., are erected, and in this way the wagon travels forward to completion at operation 10. After the erection of the draw gear at operation 5, the wagons are coupled together by special couplings which prevent them being closed together and trapping men between the buffers. The string of wagons is pulled forward by the wagon traverser, which draws the completed wagons out of the shop and transfers them to the paint shop. The services of this traverser are, of course, required every half hour.

It will be noticed from Fig. 1 that operations 7, 8 and 9 are carried out between two platforms, so that the men engaged on the various operations are conveniently placed for their work and do not require to spend time and effort in climbing about or in lifting material from the floor. A pair of roller conveyors is arranged in connection with operation 8, down which the wagon doors travel and land just in the necessary position to be swung into place. It should be added that in the course of the operations we have described, a priming coat of paint is put on the wagon sheeting and that the wagon leaves the shop ready for the other coats of paint to be applied. From the time the solebars are put in place until a finished wagon is ready to go into the paint shop covers four hours. A further point we should mention in conclusion is the large saving in space which this erection system leads to. As already mentioned, the shop in which this work is being carried out was not built for the job, and with a lay-out planned from the beginning further room could no doubt be saved, but as things are the present plant occupies five roads and is giving an output which under the old system would have required twenty. We must finish by again thanking Mr. Reid for the facilities he has put in our way to enable us to describe this very interesting work, and must also thank his assistant, Mr. E. J. H. Lemon, for his attention in connection with the matter.

# THE SHIPMENT OF LOCOMOTIVES TO INDIA.

SIR W. G. ARMSTRONG, WHITWORTH AND CO., LIMITED, ENGINEERS, NEWCASTLE-ON-TYNE.

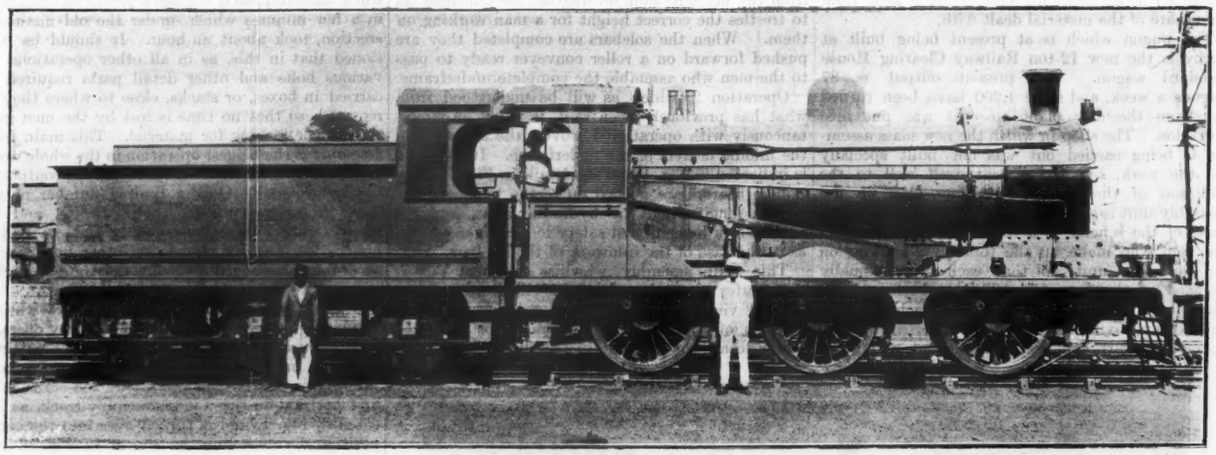


Fig. 1. 0-6-0 Locomotive for the East India Railway.

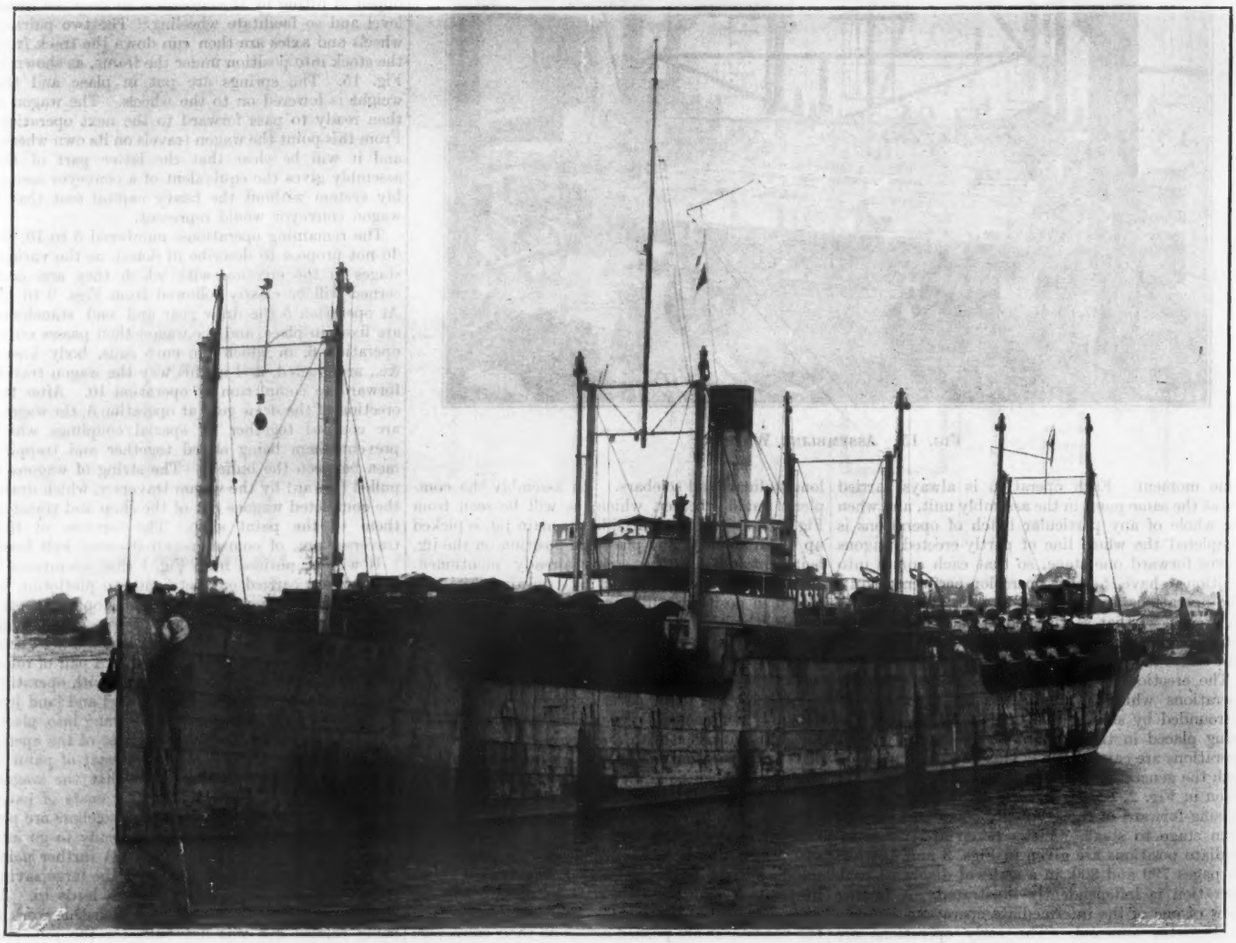


Fig. 2. The Steamship "Belgot" with Locomotives on Deck.

The locomotive building industry of this country, as is well known, is mainly dependent upon business with foreign countries and the Empire overseas. The larger railway systems here have works of their own which in a general way supply their demands, though this output is sometimes supplemented by orders to contract shops. From quite early days, however (we believe the first locomotive built for export to have left Newcastle about the year 1828) our locomotive builders have enjoyed a reputation abroad which as time has passed has become the mainspring of their prosperity, and, though rivals have arisen, the British locomotive still maintains an almost unique position in the world.

It has usually been the custom in shipping orders to distant countries to strip the engines as much as possible after erection and test in the makers works, and to protect most of the parts with timber. The

# THE SHIPMENT OF LOCOMOTIVES TO INDIA.

SIR W. G. ARMSTRONG, WHITWORTH AND CO., LIMITED, ENGINEERS, NEWCASTLE-ON-TYNE.

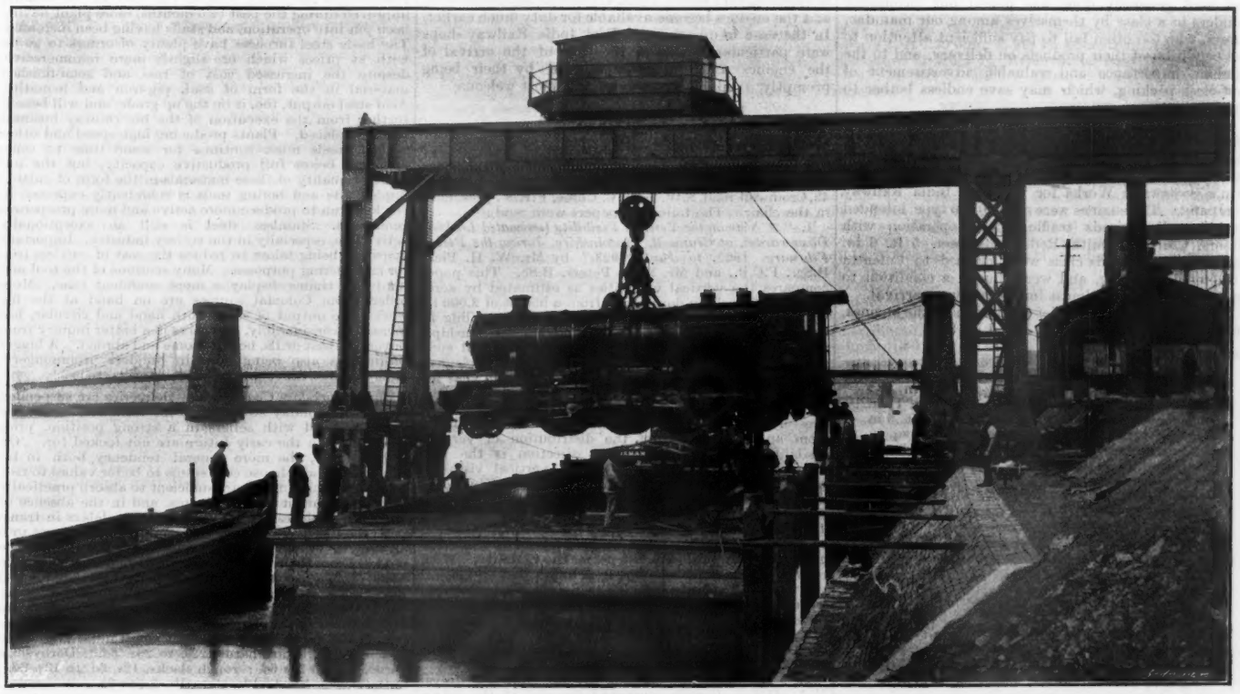


FIG. 3. LOADING A LOCOMOTIVE INTO BARGE AT SCOTSWOOD WORKS.

FIG. 4. LOADING A LOCOMOTIVE INTO SS. "BELGOT" AT ELSWICK WORKS.

boiler has been shipped separately with the mounting studs, &c., protected with wooden pads; the wheels have been taken out and the frame, with the cylinders shipped as a unit. Most of the other parts have been packed in crates or cases, and the care with which this has been generally done has placed our locomotive builders in a class by themselves among our manufacturers, who too often fail to pay sufficient attention to the condition of their products on delivery, and to the extreme importance and valuable advertisement of first-class packing, which may save endless bother to the consignee.

An interesting departure from the usual practice of dismantling for shipment has recently been made by Messrs. Sir W. G. Armstrong, Whitworth & Co., Limited, in the case of an order of locomotives built at that firm's Scotswood Works for the East India Railway Company. The engines were of the 0-6-0 type, intended for main line goods traffic. In co-operation with Messrs. Christen Smith Rederei, thirteen 5 ft. 6 in. gauge engines of this class were shipped to Calcutta without dismantling, and were thus in a condition to be put into service almost immediately on arrival.

The following are the chief particulars of the engines, one of which is illustrated in Fig. 1, p. 802.

*Locomotive:*

| | |
|---|---|
| Cylinders, diameter ... ... ... | 20 in. |
| Cylinders, stroke ... ... ... | 26 in. |
| Wheels, coupled ... ... ... | 5 ft. 1½ in. |
| Wheelbase, rigid ... ... ... | 15 ft. 6 in. |
| Heating surface tubes ... ... | 917 sq. ft. |
| Heating surface, firebox ... ... | 126·3 sq. ft. |
| Heating surface, total ... ... | 1,043·3 sq. ft. |
| Superheater surface ... ... ... | 223 sq. ft. |
| Grate area ... ... ... ... | 25·3 sq. ft. |
| Working pressure ... ... ... | 160 ft. per square inch |
| Weight in working order ... ... | 50·95 tons. |

*Tender:*

| | |
|---|---|
| Wheels, diameter ... ... ... | 3 ft. 7 in. |
| Tank capacity ... ... ... | 3,000 galls. |
| Coal space ... ... ... ... | 7½ tons. |
| Weight in working order ... ... | 40·25 tons. |

*Locomotive and Tender:*

| | |
|---|---|
| Wheelbase, total ... ... ... | 39 ft. 0½ in. |
| Weight in working order ... ... | 91·20 tons. |

By suitable alterations to the ss. Belgot of Messrs. Christen Smith Rederei, carried out at Messrs. Armstrong's Naval yard it became possible to load 12 engines and one tender on this vessel's deck, and one engine and 12 tenders in her hold, together with four other engines stowed in the usual manner in crates and cases. A view of the vessel showing her deck load of 12 engines and 1 tender, is given in Fig. 2 on page 802. The locomotives, built at Scotswood, were loaded there on barges by means of the gantry shown in Fig. 3 on page 803. They were loaded on to the ss. Belgot at the Elswick Jetty, which is served by a 150-ton hydraulic crane, the ship having been brought alongside on September 18 last. The vessel was cleared on September 23. Fig. 4, page 803, shows the engines being loaded at the Elswick jetty.

The Belgot commenced her voyage on September 24 and after stopping at Oran, Port Said and Aden, and meeting very heavy weather, arrived in the Hooghly, off Calcutta, on October 3, having maintained an average speed of 10·2 knots. The tarpaulin covers were removed from the deck-borne engines on the way up the river, but the vessel was not able to berth in the Kidderpore Docks until noon on October 5, as the berth served by the sheer legs was occupied. However, by 6 p.m. the same day the first six locomotives had been safely unloaded, the first engine being hauled away to the East India Railway Company's locomotive sheds at Dock Junction East, at 7.30 p.m., Figs. 5 and 6, page 806, show the unloading operations.

The first engine was thoroughly examined, and its boiler tested by the East India Railway staff on Saturday, October 6. The result was perfectly satisfactory, all joints, &c., being found in good condition. On Monday, October 8, the engine was steamed, and by 11 a.m. was ready to leave up-country, its destination being Jha Jha, 210 miles from Calcutta. The run was commenced at 1 p.m., a stop being made at Bandal, 30 miles out, for inspection. All being found satisfactory the journey was continued to Asansol, a distance of 90 miles, this section being run ahead of the Punjab Mail. The remaining stretch to Jha Jha was accomplished without incident, and the engine arrived in excellent condition at its destination. Two days later the engine was passed into regular service.

The remaining engines were turned over to the railway as fast as the Dock Junction staff could deal with them and all were cleared by October 20. We understand that after the first few engines, the examination of which showed that they had sustained no damage during shipment, a good deal of the opening up for inspection was dispensed with.

The success which attended the whole undertaking has proved the entire practicability of shipping locomotives in this manner, and the method could, of course, be extended to any part of the world where sufficient unloading facilities are provided. In many cases it will probably result in a considerable change of method for the advantages gained on arrival at their destination are obvious. The time and labour charges for re-erection, very heavy items, are completely eliminated, and the engines become available for duty much earlier. In the case in question the East India Railway shops were particularly busy at the time of the arrival of the engines and the relief afforded by their being promptly available for service was most welcome.

## ROYAL METEOROLOGICAL SOCIETY.

The usual monthly meeting of this society was held on Wednesday, the 19th inst., at the Society's Rooms, 49, Cromwell-road, S.W. 7, Dr. C. Chree, F.R.S., president, in the chair. The following papers were read:—

1. "*A Note on the Vertical Visibility (estimated Looking Downwards), at Cranwell, Lincolnshire, during the Period February, 1922, to June, 1923,*" by Mr. W. H. Pick, B.Sc., F.C.P., and Mr. S. P. Peters, B.Sc. This paper compares the vertical visibilities as estimated by aeroplane pilots looking downwards from a height of 2,000 ft. with various other meteorological factors prevailing at the time, with a view to discovering what relationships, if any, exist between the vertical visibilities and such factors. The pressure type is the first meteorological element considered in this way, and it is found that for at least seven of the 15 types of Gold's classification the vertical visibility bears a definite relationship to the pressure type. The most outstanding feature resulting from an investigation of the distribution of vertical visibility with regard to wind direction is the predominance of "excellent or good" vertical visibility with surface winds blowing from between east by north and east south-east. Surface wind velocity appears to be unrelated to the degree of vertical visibility experienced. The wind velocity at 2,000 ft., on the contrary, is shown to bear a somewhat intimate connection, in that the greater the wind velocity, the poorer the visibility. With regard to low cloud amount, it is found that in general the vertical visibility appears to decrease progressively with increasing low cloud amount, and it is further observed that the presence of surface convection currents is accompanied by good vertical visibility. The relationship between vertical and ground horizontal visibility is shown to be but slight.

2. "*The Cause of Cyclones,*" by Mr. Harold Jeffreys, M.A., D.Sc., Certain suggested theories of the origin of cyclones of various types are briefly discussed from the theoretical standpoint, The fixed cyclone of Continental dimensions that produces the monsoons can be explained as a steady motion under the influence of a variation of temperature over horizontal surfaces. Instability convection may explain thunderstorms. A millpond eddy theory may explain tropical cyclones. Waves in the polar front are likely to have a wave-length comparable with that shown in cirro-cumulus clouds, but not that of cyclones. The mixing of air from the two sides of the polar front, however, must produce air with a tendency to rise, and it is possible that such air may provide the mechanism of the cyclones of temperate regions.

3. "*The Relation of the Circulation in the Upper Air to a Circumpolar Vortex,*" by Mr. A. W. Lee, M.Sc., A.Inst.P. The circulation of the upper air in the region between 30 deg. N. and 70 deg. N., as determined from the isobars at 4 km., 6 km. and 8 km., is approximately the motion of a series of V/r vortices. It appears that each layer is an aerosphere which rotates around the polar axis as a solid, but on ascent there is relative motion between consecutive aerospheres; the velocity of the aerospheres in different latitudes is shown by a series of curves. The circulations which must be superimposed upon solid rotation at 4 km. in July in order to give the observed distribution of pressure are obtained."

Personal.—We are asked by the White Machine Tool Company to announce that they have changed their business premises from Warley Springs Works, Halifax, to Dunkirk Works, Parkinson-lane, Halifax, where they will continue the manufacture of planing machines of all kinds and special machine tools under more favourable conditions.

The Institution of Automobile Engineers.—The Council of the Institution of Automobile Engineers has established a medal to be awarded to a member of any grade for any paper or similar service which may be considered likely to have special influence on the advancement of automobile engineering. The medal, which is of bronze, bears on its obverse side a replica of the head of Dr. F. W. Lanchester as symbolical of progress in the industry. We are glad to learn that the council has decided to award the first medal to Dr. Lanchester for his contributions to scientific knowledge.

Flux-coated Electrodes for Arc-welding.—We have received from the Ferro-Arc Welding Company, Limited, of 12, Grosvenor Gardens, London, S.W. 1, particulars of their new flux-coated electrodes, which consist of a mild steel core covered with a special flux. The electrodes, which are made in England, are not only particularly moderate in price, but it is claimed for them that welding may proceed with them with no more attention to the slag than when bare wire is used. In general circumstances one or more "runs" may be made on top of the original "run" without removal of the slag. The latter breaks away by itself from the finished weld on cooling.

## NOTES FROM SOUTH YORKSHIRE.

Sheffield, Wednesday.

*Iron and Steel.*—While production is virtually suspended this week, the bulk of steel-making and engineering concerns will re-open with improved order books. Following a temporary relapse, the position has steadily improved during the past two months, more plant having been put into operation, and staffs having been increased. The basic steel furnaces have plenty of orders to go on with at prices which are slightly more remunerative, despite the increased cost of raw and semi-finished material in the form of coal, pig-iron and hematite. Acid steel output, too, is on the up grade, and will benefit further from the execution of the big railway business recently placed. Plants producing high-speed and other special steels must continue for some time to come at much below full productive capacity, but the unrivalled quality of these materials in the form of cutting implements and boring tools is confidently expected in the long run to produce more active and more prosperous conditions. Stainless steel is still an exceptionally active line, especially in the cutlery industry. Important steps are being taken to reduce the cost of rustless iron for engineering purposes. Many sections of the tool and hardware trades display a more confident tone. More orders from Colonial sources are on hand at the file works, the output of saws, both hand and circular, has increased considerably, and there is a better inquiry from buyers of twist drills, both at home and abroad. A bigger business is also being done in builders' ironmongery, light castings, stove grates, and engineers' tools.

*South Yorkshire Coal Trade.*—Deliveries are suspended during the holiday stoppage at the collieries, but as the market closed with sellers in a strong position, price concessions in the early future are not looked for. On the contrary, the more general tendency both in industrial fuel and house coal seems to be for values to rise. Contract commitments are sufficient to absorb practically the whole output of best steams, and in the absence of adequate facilities for delivery owing to delays in transport, the discharge of domestic requirements has got into arrear. It is expected that railway contracts over the next six months for best steams will be renewed on the basis of 21*s.* per ton. Quotations:—Best handpicked branch, 33*s.* to 34*s.*; Barnsley best Silkstone, 27*s.* 6*d.* to 29*s.*; Derbyshire best brights, 27*s.* to 29*s.*; Derbyshire best house coal, 23*s.* to 24*s.*; Derbyshire best large nuts, 22*s.* to 23*s.* 6*d.*; Derbyshire best small nuts, 17*s.* 6*d.* to 19*s.* 6*d.*; Yorkshire hards, 22*s.* to 23*s.* 6*d.*; Derbyshire hards, 21*s.* to 22*s* 6*d.*; rough slacks, 12*s.* 6*d.* to 13*s.* 6*d.*; nutty slacks, 10*s.* to 12*s.*; smalls, 5*s.* to 8*s.*

Vulcan Commercial Motor.—In our article on the Commercial Motor Transport Exhibition, there was a statement made on page 692, present volume, relating to the Vulcan engine, which requires amendment. The last sentence in column 2 should be changed from "a drive is also taken from the crankshaft by belt to work the fan" to "a drive is also taken by belt from a pulley mounted on the forward end of the pump and magneto driving spindle, to work the fan."

The Engineering Society of University College, London.—It has been arranged that the annual dinner of this Society shall be held on Friday, February 1, 1924. The dinner will be held in the college refectory. After dinner, a conversazione will be held in the Engineering Building, so as to afford members an opportunity of seeing the new engineering laboratories. Old students of the Faculty of Engineering who wish to be present are invited to communicate forthwith with the Hon. Secretary of the Engineering Society, University College, London.

Italian Naval Construction.—The flotilla leader Leone and the destroyer Monzambano were recently launched. The Leone displaces 2,165 tons, her horsepower is 50,000, and her speed 35 knots; her length is 360 ft.; her beam, 34 ft.; and her armament, eight 4·7-in. guns in twin mountings; two 3-in. anti-aircraft guns and two twin 21-in. torpedo tubes. The Monzambano displaces 925 tons, and has a horse-power of 27,000; her speed is 33 knots; her length is 277 ft.; her beam, 34 ft.; and her draught 11½ ft. Her armament consists of four 4-in. guns; two 3-in. anti-aircraft guns, and two triple 18-in. torpedo tubes. Both vessels will be completed early next year. By the end of 1924 there will be three flotilla leaders of the Leone class and seven destroyers of the Monzambano class in full commission in the Italian navy.

On Overcrowding in the Engineering Profession.—Mr. F. S. Keith, general secretary of the Engineering Institute of Canada, stated recently, according to *The Canadian Engineer*, that the profession is overcrowded, and he advised potential engineers to seek other outlets for their energies. Engineering schools and colleges in Canada were every year turning out more qualified engineers than the progress of the country could possibly absorb. He instanced the lack of professional employment among engineers, and said that only recently three full members of the Society had asked for employment. One was trying to sell bonds, another was selling office supplies, and the third was a life-insurance agent. He mentioned two other members working as carpenters, whilst another had found employment as a missionary in China. Among Mr. Keith's suggestions was one to the effect that engineers should study and practice the art of public speaking, so that they could not only go ahead as engineers but take their part in the ordinary life of the Country with credit to themselves and their profession.

## NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

*The Cleveland Iron Trade.*—With holiday-making general, transactions are hardly heard of, and quotations are largely nominal. Cleveland pig-iron is none too plentiful, and that there is confidence in the future is emphasised by reports of recent forward buying at rather above current rates. Demand is almost entirely for home use, there being next to no export inquiry. Output is to be increased early in the New Year by the blowing-in of an additional blast-furnace at the Clarence Ironworks of Messrs. Bell Brothers. No. 1 Cleveland pig-iron is 106*s.*; No. 3 g.m.b., 100*s.*; No. 4 foundry, 97*s.* 6*d.*; and No. 4 forge, 96*s.* 6*d.*—all f.o.t. makers' works, and f.o.b. Tees.

*Hematite.*—Increased production of East Coast hematite is not throwing surplus iron on the market. One or two Continental inquiries are in the market, but they are of trifling dimensions, demand in this branch also being chiefly for home requirements which promise to continue to expand. Nos. 1, 2 and 3 are fully 102*s.* 6*d.* for prompt business, and 103*s.* 6*d.* for delivery early in the New Year. No. 1 is quoted a shilling above mixed Nos.

*Blast Furnaces in Operation.*—With the additional blast furnace that is being re-lighted at the Clarence Works next week there will be 49 in operation on the North-East Coast, of which 15 will be making Cleveland pig-iron, 17 producing hematite, and 17 manufacturing other kinds of iron. In normal times the total number of furnaces blowing is about 70.

*Blast-Furnace Coke.*—Durham blast-furnace coke is fairly plentiful, and medium kinds are on sale at 37*s.* to 37*s.* 6*d.* delivered to users here.

*Foreign Ore.*—There is a continued firm feeling in foreign ore. Market quotations are based on 25*s.* c.i.f. Tees for best rubio.

*Manufactured Iron and Steel.*—Manufactured iron and steel producers have a lot of work on hand, and they expect to secure further substantial contracts. Works are closed this week for the holidays, and firms are thus enabled to carry out essential repairs and renewals to machinery. Among the principal market quotations are: Common iron bars, 12*l.*; iron rivets, 14*l.*; packing (parallel), 8*l.* 10*s.*; packing (tapered), 11*l.* 10*s.*; steel billets (soft), 9*l.*; steel billets (medium), 10*l.*; steel billets (hard), 10*l.* 5*s.*; steel boiler plates, 13*l.* 10*s.*; steel ship, bridge and tank plates, 10*l.* 5*s.*; steel angles, and joists, 10*l.*; heavy sections of steel rails, 9*l.* 10*s.*; fish plates, 13*l.*; and galvanised corrugated sheets (24 in. gauge, in bundles), 18*l.* 15*s.*

INFLUENCE OF MOISTURE ON CHEMICAL REACTIONS.—Since H. B. Dixon observed in 1884 that mixtures of carbon monoxide and oxygen, which an electric spark explodes, would no longer explode when thoroughly dried, other evidence has been adduced apparently indicating that two dry gases or substances might not combine at all in the absence of all traces of moisture or possibly of other third bodies. But there have also been contradictions, and as it is almost impossible to expel all moisture from many materials and apparatus without risking their destruction, the problem remains obscure. Working with Professor A. Coehn at Göttingen, H. Tramm (Zeitschrift Physikal. Chemie 105, pages 357-401) dries his purified materials in apparatus consisting of several U-tubes joined in series to a high vacuum pump and placed separately in liquid air and other freezing agents so that the respective gas or vapour can be drawn from one tube into another and finally into the receptacle; he thus reduces the aqueous vapour pressure of his gases to less than 0·004 mm. He finds that the carbon monoxide-oxygen mixture which could no longer be exploded, and which reacted very slowly only when heated, would explode on exposure to the rays of a quartz-mercury lamp, both in the dry and moist condition. On the other hand, carbon dioxide was slowly decomposed by light only in the presence of traces of moisture or of sulphur dioxide. Mixtures of hydrogen and oxygen, so dry that they would not explode on exposure to light and combine very slowly only when heated in quartz vessels to red glow, exploded at once when exposed to ultraviolet rays; ultraviolet rays likewise exploded the moist mixtures. Whether or not hydrogen and chlorine, which if moist explode on exposure to sunlight, will rapidly combine when perfectly dry, is still uncertain. On the other hand, again, ultraviolet rays decomposed the hydrochloric acid only when moist, whilst in the cases of the hydrobromic and hydroiodic acids the presence or absence of moisture made no difference in the rate of decomposition by ultraviolet light. Many other reactions have been studied by Tramm, also by drying the gases in the usual way with the aid of phosphorus pentoxide. Keeping his gases and even liquids in contact with this drying agent for nine years, Professor H. Brereton Baker, of South Kensington, has observed some very peculiar changes in many substances. Thus boiling points were raised, that of bromide by 53 deg. C., mercury by 66 deg., ethylalcohol by 60 deg., carbon disulphide by 30 deg.; some melting points were also raised, that of sulphur by 5·5 deg., iodine by 2 deg., but the densities remained unchanged. Professor Baker, who last month obtained the Davy medal of the Royal Society for this and other work, ascribes the changes to an assumption of molecular complexity. Tramm confirms Baker's observation that perfectly dry hydrochloric acid and ammonia will not combine; but he found it impossible to dry some of his substances, especially the hydrochloric acid, by contact with the pentoxide (as Baker had done) because reaction set in.

## NOTES FROM THE NORTH.

GLASGOW, Wednesday.

*The Trade Position.*—With the year fast drawing to a close business is slacking off and buyers are not very much in evidence. After passing through such quiet times as have recently been experienced it is exhilarating to think that the general trade outlook is very much better. Shipbuilding promises to be more active before long, and if many of the contracts now under negotiation are secured by Clyde firms the local yards will be fairly busy by the spring. Quite a number of orders are already on the books and employment is gradually improving. The railway companies have lately been placing orders for material amounting to several million pounds, and firms in this district have been fortunate in securing a goodly share. Rails, wagons, locomotives, &c., are included in this buying movement, and the firms who have received the orders are ensured steady running for some months. Both steel and iron works will participate in the new business, and many other industries will also benefit both directly and indirectly with the result that the general trade position in the Glasgow area should be much better in the early days of the New Year.

*Scottish Steel Trade.*—There is little fresh to report in connection with the Scottish steel trade this week. Orders recently booked have already made a difference at the various works and quite a fair tonnage of general material has been secured, and an improved demand is anticipated for shipbuilding material in the near future. While order books have been slowly filling up producers are ready to tackle a much larger demand, and are hopeful that a better *regime* may prevail after the turn of the year. The black sheet makers are fairly well off for business at present both in light and heavy gauges, but particularly for the former. For galvanised sheets there is a much healthier demand and a fairly satisfactory amount of new business has been booked. Prices all round are very firm, but are practically unaltered this week.

*Malleable Iron Trade.*—A slight improvement falls to be noted in the West of Scotland malleable-iron trade and conditions are again better. Not only is bar iron in better request, but there is considerably more business passing for re-rolled steel. The position on the whole shows improvement. Prices are unchanged.

*Scottish Pig-Iron Trade.*—The home demand for Scottish pig-iron continues good, and a steady output is general. Fairly large deliveries of hematite are being made to the steel works, and foundry iron is also moving freely. In the export side of the industry things are quieter as the demand has fallen off to some extent, but an early improvement in that direction is anticipated. Prices are all strong and with an upward tendency.

SWEDISH RUST-PROOF IRON.—It has been announced, or rather it has been inadvertently made known, says *Swedish Export*, that the Aktiebolaget Ferrolegeringar of Trollhättan have perfected a new method of producing rust-free iron and mild steel on a commercial scale, at a cost which will make it available for many ordinary uses. Mr. Danielis, the chief engineer of Ferrolegeringar, has confirmed the claim that the company can now produce an iron which is impervious to the action of all acids. The new metal or alloy which has a fine silver-grey colour may be rolled into all usual sections. There is every reason to presume that it will have a great field of utility. This chrome iron or steel is certainly more expensive, but it is estimated that a roof covered with it will not cost above 50 per cent. more than one covered with galvanised sheets. As a trial it has been decided to make the deck of a steamer under construction of the new material. The principal component of the chrome iron is Swedish iron. The ore used in the alloy comes from Rhodesia, South Africa.

SOLUBILITY OF MINERAL DUSTS IN WATER AND OTHER SOLVENTS.—In sampling the air of dusty mines and industrial plants the United States Bureau of Mines makes use of "impinger tubes" of glass charged with distilled water through which the air is aspirated, and also of sugar tubes, charged with grains of solid sugar which retain also the finest dust very well. There may be considerable delay before the sampling and the actual determination of the solid fine particles—by filtering through Gooch crucibles—and since fine particles are notoriously soluble, much more than coarse grains, solubility might account for the discordant results obtained with the different impingers. On behalf of the Bureau, W. Myers according to Reports of Investigations, Serial No. 2,548 has conducted experiments with different collecting media, distilled water, ethyl alcohol of 95 per cent., and kerosene. Since glass is itself soluble in water, especially common glass, comparative tests were made with vessels of ordinary glass, pyrex glass and platinum. The dusts selected, a very pure Bedford limestone and some siliceous cherts (with 98·5 per cent. of silica) all contained much very fine dust; less than 10 microns (1 micron = 0·001 mm.) in diameter. The limestone proved practically insoluble in the three media. The silica was insoluble in the alcohol and the kerosene, but distinctly soluble—exceptionally so, in fact, probably because of colloidal character—in water. The finest silica particles seemed to dissolve within the first 24 hours, but the dissolution proceeded during the 28 days of the experiments. The report, therefore, does not recommend water as collecting medium; kerosene is objectionable because it renders the subsequent analyses very troublesome. Alcohol, *i.e.*, methylated spirits, is recommended; the loss by evaporation would cause much expense; it is not pointed out, however, that alcohol would dissolve many dusts.

## NOTICES OF MEETINGS.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, January 3, at 6 p.m., Lecture on "Railway Electrification in Foreign Countries," by Dr. S. P. Smith, Member.

THE JUNIOR INSTITUTION OF ENGINEERS.—Friday, January 4, at 7.30 p.m., at 39, Victoria-street. Lecturette, "Economy of Fuel by Removal of Soot from Boiler Tubes," by Mr. L. Manico (Member). (Exhibits and diagrams.)

## NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

*The Coal Trade.*—The certificate of the joint accountants for the South Wales coalfield for the two months of September and October states, that after allowing for the standard wages, other costs, and the owners' standard profits, the general wage rate percentage payable in the coalfield in January and February next will be 28 per cent. on the 1915 standard rates compared with the rate of 28·66 per cent. in November and December. The audit shows that after allowing for standard wages, other costs, and standard profits there is a surplus of 959,933*l.* Under the agreement this sum is distributable in the proportion of 83 per cent. to the workmen and 17 per cent. to the owners, and is only enough to justify a general wage rate of 26·93 per cent. on the 1915 standard rates, and, accordingly the owners will have to pay the miners' their minimum wage of 28 per cent. on the 1915 standard rates, and to do this they will have to sacrifice 42,000*l.* of their share of the proceeds to which they are entitled under the agreement. Several factors contributed to the fall in the general wage percentage. There was a steady decline in prices since the peak point was reached in May last. In October the average pithead price of coal was 19*s.* 9·31*d.* per ton, compared with 21*s.* 5·45*d.* in May, and when the prices for September and October are compared with those of July and August there is a reduction of 5½*d.* per ton. The output in September and October, however, was higher, and for this reason the wages cost is 2½*d.* per ton less. The position in regard to output and costs has thus been reversed, for in July and August the cost of production was increased by low outputs. The fall in the price of coal was the result of the reaction in the European demand and the deterring influence of costs on the demand from the more distant markets. The production in September and October was at the rate of about 52,000,000 tons per annum, compared with a pre-war output of 57,000,000 tons. The total wages paid in September and October amounted to 5,583,594*l.*, as compared with only 3,297,973*l.* in the corresponding period of 1913, or 2,285,621*l.* more than in the pre-war year.

*Traders and the Railways.*—Representatives of the South Wales Chambers of Commerce and National and Local Traders' Associations met at Cardiff last week for the purpose of forming a South-East Wales and Monmouthshire Traders' Panel under the Railways Act, 1921. It was decided that the panel should consist of representatives of every *bona fide* trade association and organisation, or firm, where no parent organisation existed. An executive committee of 17 was also agreed upon, the agricultural interests, fruit and potato trades and the newspapers being entitled to appoint one representative each. The Railway Panel has already been formed and a meeting of the two panels will shortly be held.

SYMONS GOLD MEDAL OF THE ROYAL METEOROLOGICAL SOCIETY.—The Council of the Royal Meteorological Society has awarded the Symons gold medal for 1924 to Dr. Takematsu Okada, director of the Central Meteorological Observatory, Tokyo, Japan. The medal is awarded for distinguished work in connection with meteorological science and will be presented at the annual general meeting on January 16, 1924.

INSPECTION OF AMERICAN ROLLING-STOCK.—According to the Interstate Commerce Commission's monthly report on the condition of railway equipment, 6,507 locomotives were inspected during October by the Bureau of Locomotive Inspection, and 55 per cent. were found defective, whilst 525 were ordered out of service; 103,287 freight cars were inspected, of which 4·7 per cent. were found defective; also 2,300 passenger cars, of which 1·5 per cent. were found defective.

THE DIESEL ENGINE USERS' ASSOCIATION.—Mr. A. W. A. Chivers (British Electrical Federation, Limited) has been elected president of the Diesel Engine Users' Association for the year commencing January 1, 1924. With regard to the honorary secretaryship, arrangements have now been made to relieve Mr. Percy Still of some part of the duties which he has attended to during the last ten years by appointing joint honorary secretaries. Messrs. Percy Still, M.I.E.E., and Geoffrey Porter, A.M.Inst.C.E., have been elected as joint honorary secretaries.

AUTOMOBILE ACCIDENTS IN THE UNITED STATES.—The Department of Commerce has announced that according to the returns of the Bureau of Census there were 11,666 deaths caused by automobiles and other motor vehicles (excluding motor cycles) in the United States in 1922. This represents a death rate of 12·5 per 100,000 population for the year, as against 11·5 in 1921, 10·4 in 1920, 9·4 in 1919, 9·3 in 1918 and 9 in 1917.

# THE SHIPMENT OF LOCOMOTIVES TO INDIA.

SIR W. G. ARMSTRONG, WHITWORTH AND CO., LIMITED, ENGINEERS, NEWCASTLE-ON-TYNE.

(*For Description see Page* 802.)

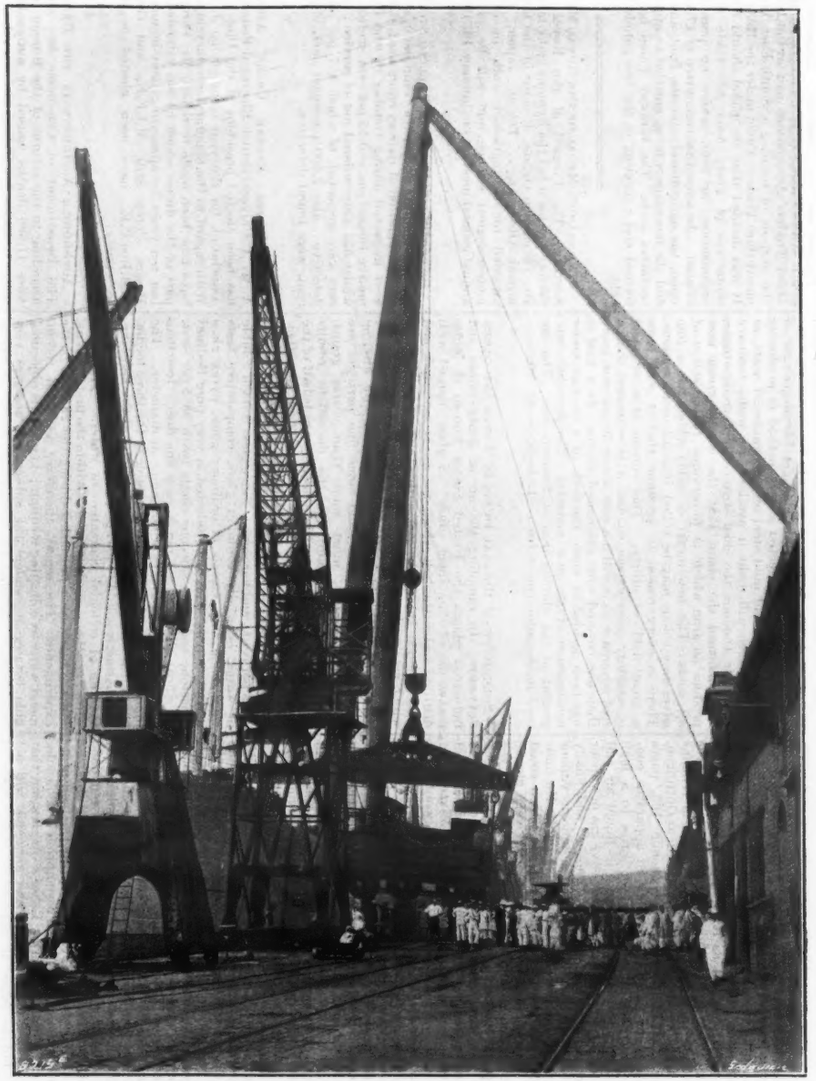


FIG. 5.

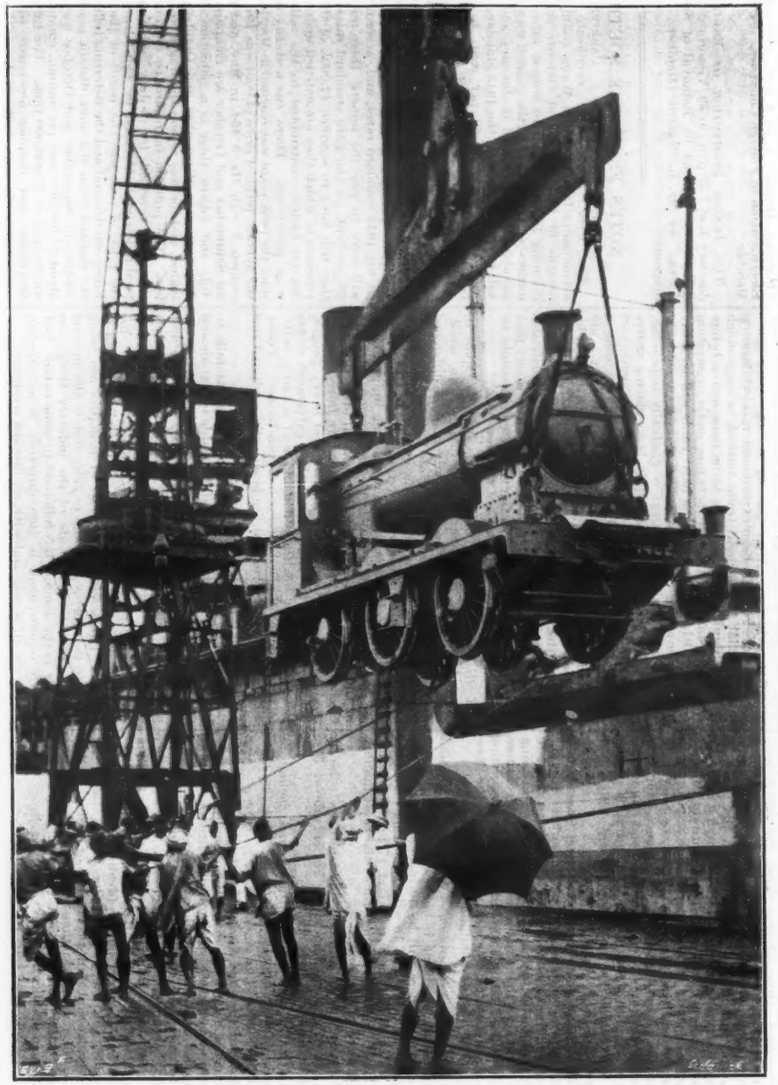


FIG. 6.

FIGS. 5 AND 6. DISCHARGING LOCOMOTIVES AT KIDDERPORE DOCKS, CALCUTTA.

FIGS. 5 AND 6. DISCHARGING LOCOMOTIVES AT KIDDERPORE DOCKS, CALCUTTA.

# THE MOTOR CARGO SHIP "MARGRETIAN," WITH BEARDMORE-SPEEDWELL OIL ENGINES.

(For Description, see Page 791.)

*Fig. 2.*

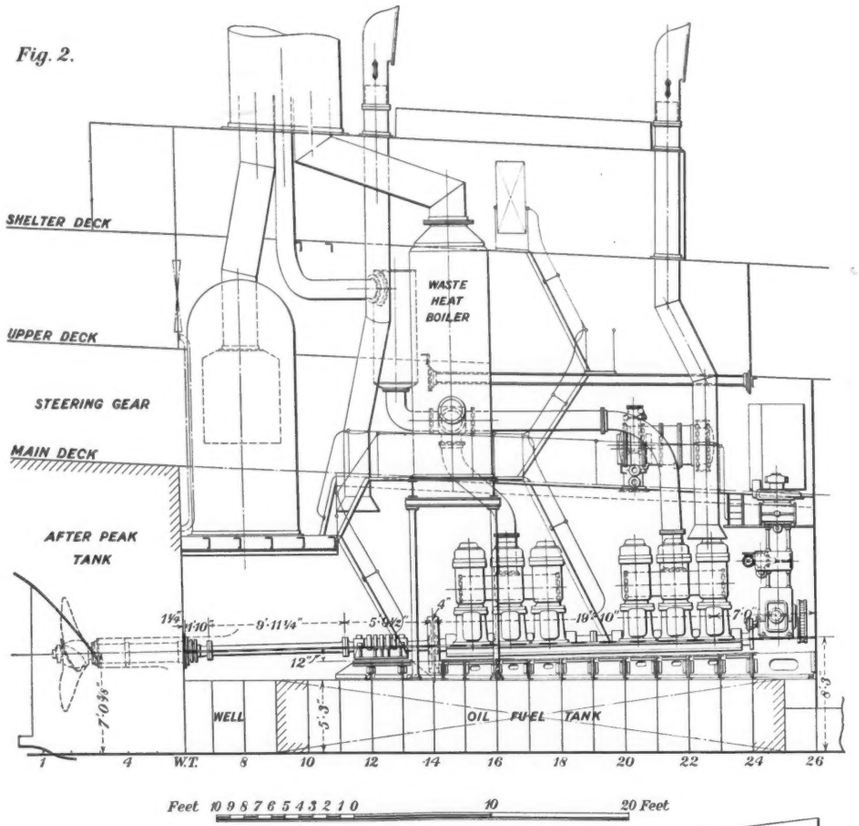
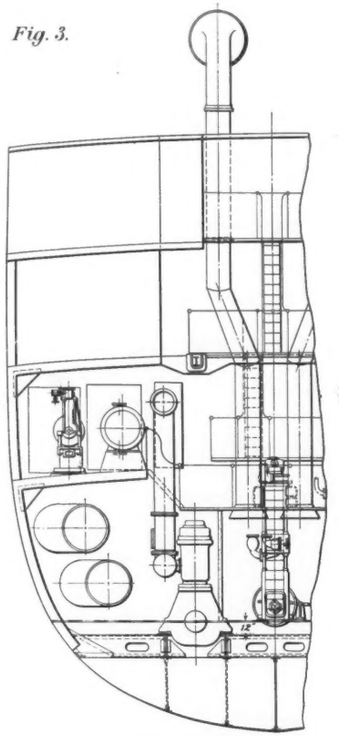
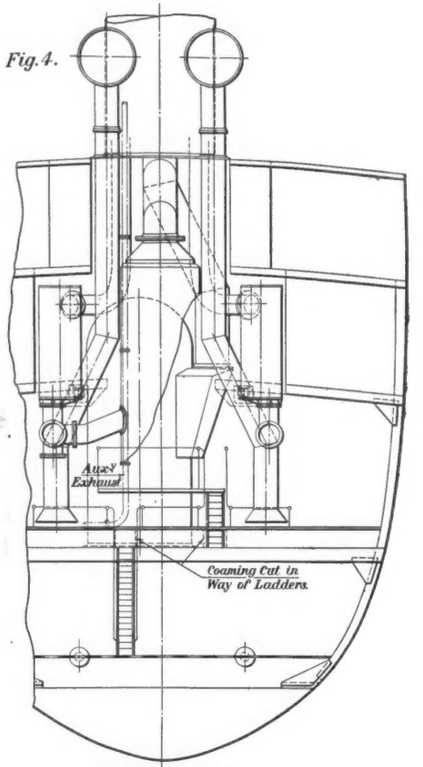



*Fig. 3.*



SECTION AT FR. 20 LOOKING FOR$^{D}$

*Fig. 4.*




SECTION AT FR. 10 LOOKING AFT.

*Fig. 5.*

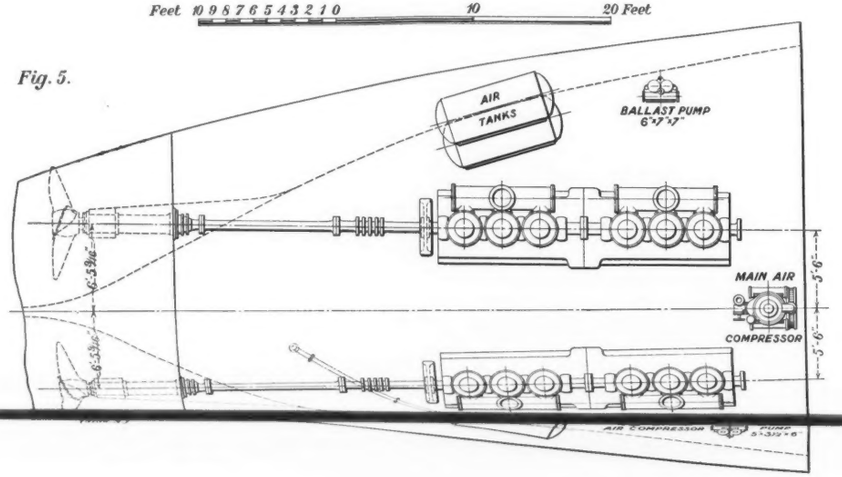
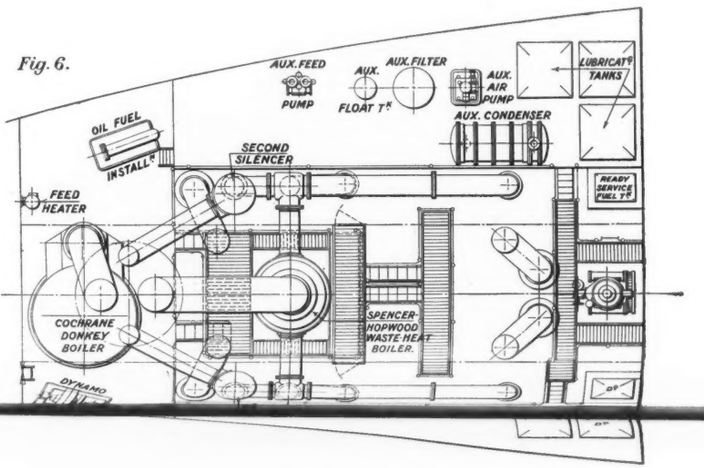
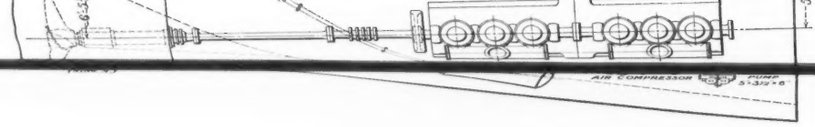



*Fig. 6.*





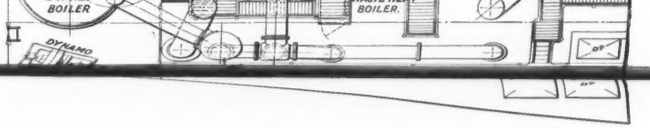
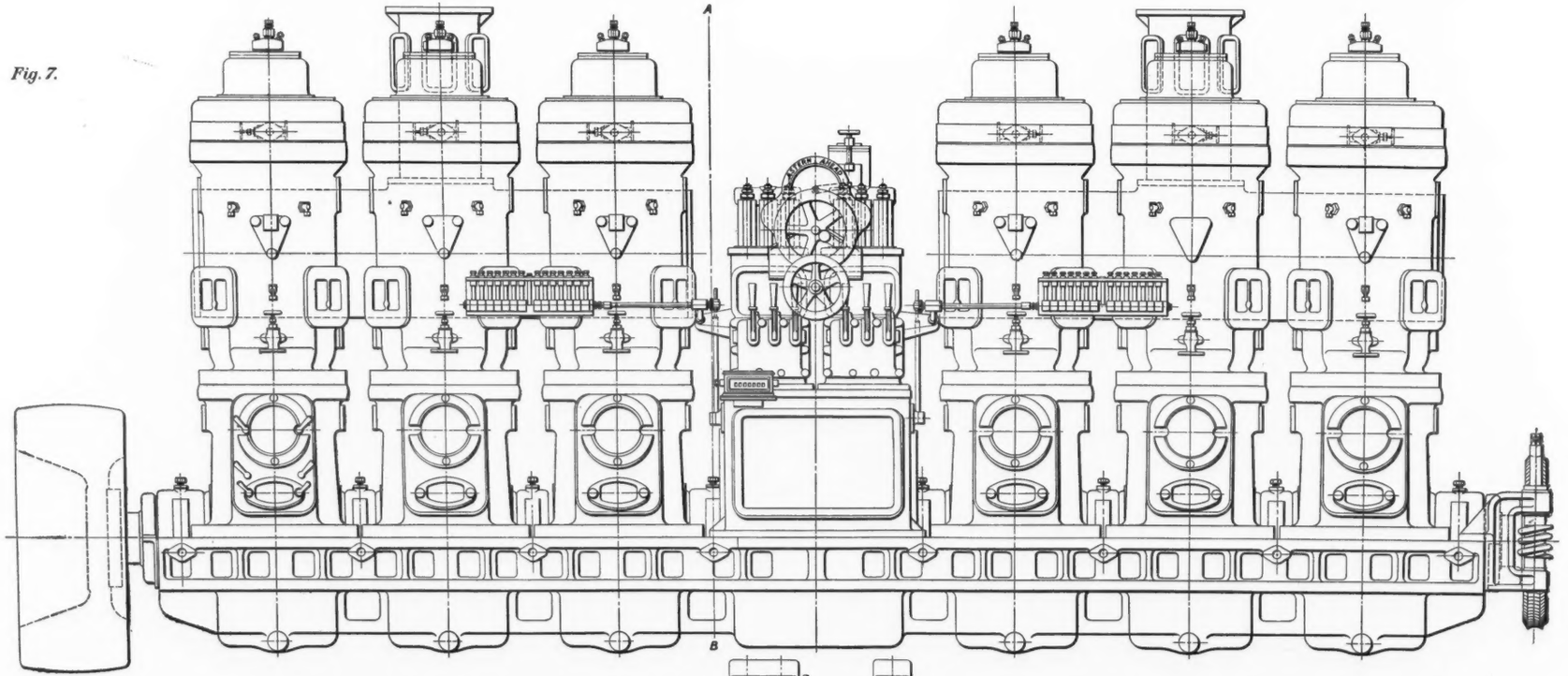
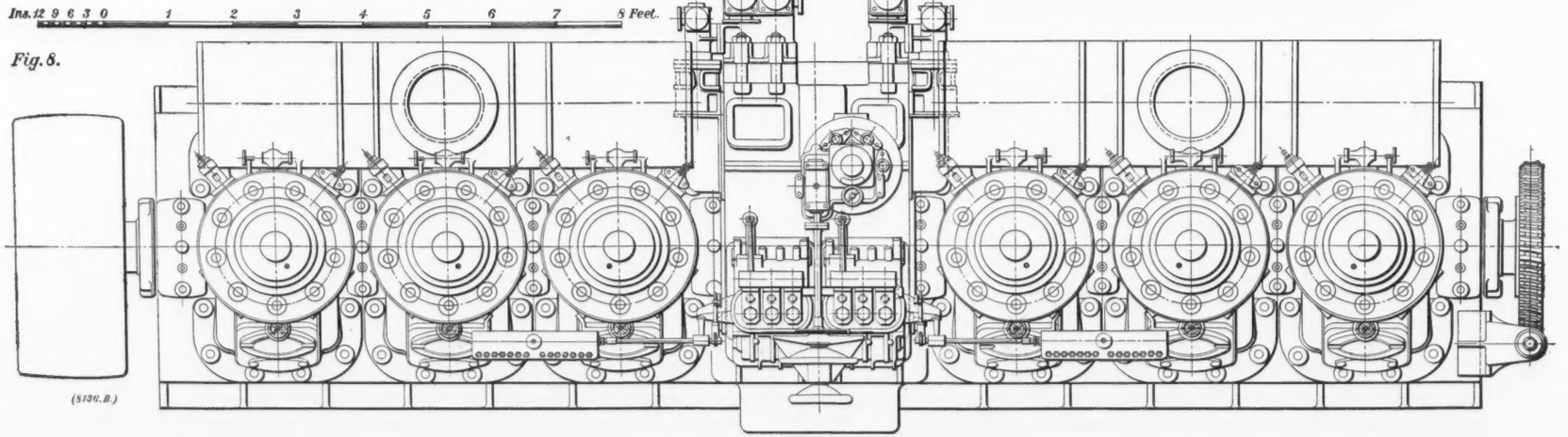




*Fig. 7.*




Ins. 12 9 6 3 0 1 2 3 4 5 6 7 8 Feet.

*Fig. 8.*



(5136. B.)

# ENGINEERING.

**Offices for Publication and Advertisements, 35 and 36, Bedford Street, Strand, London, W.C.2.**

**We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.**

TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.

TELEPHONE NUMBERS—3663 and 8598 GERRARD.

## SUBSCRIPTIONS, HOME AND FOREIGN.

**"ENGINEERING" may be ordered from any newsagent in town and country and at railway bookstalls, or it can be supplied by the Publisher, post free, at the following rates, for twelve months, payable in advance:—**

| | | | |
|---|---|---|---|
| For the United Kingdom | £3 | 5 | 0 |
| For Canada— | | | |
| Thin paper copies | £2 | 18 | 6 |
| Thick paper copies | £3 | 3 | 0 |
| For all other places abroad— | | | |
| Thin paper copies | £3 | 3 | 0 |
| Thick paper copies | £3 | 7 | 6 |

**Foreign and Colonial subscribers receiving incomplete copies through newsagents are requested to communicate the fact to the Publisher, together with the agent's name and address.**

**When foreign subscriptions are sent by Post Office Orders, advice should be sent to the Publisher.**

## ADVERTISEMENT RATES.

**The charge for advertisements classified under the Headings of Appointments Open, Situations Wanted, Tenders, &c., is four shillings for the first four lines or under, and one shilling per line up to one inch. The line averages seven words. When an advertisement measures an inch or more the charge is 12s. per inch. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.**

## TIME FOR RECEIPT OF ADVERTISEMENTS.

**Advertisements intended for insertion in the current week's issue must be delivered not later than First Post on Thursday. In consequence of the necessity of going to press early with a portion of the edition, alterations for standing advertisements should be received on the Friday previous to the day of publication.**

**All accounts are payable to ENGINEERING, LTD. Cheques should be crossed "The National Provincial and Union Bank of England, Limited, Charing Cross Branch." Post-Office Orders should be made payable at Bedford-street, Strand, W.C. 2.**

## AGENTS FOR "ENGINEERING."

AUSTRALIA: Gordon and Gotch, Limited, Melbourne; Sydney; Brisbane; Perth. Angus and Robertson, Limited, Sydney, N.S.W. T. Willmett and Co., Townsville, North Queensland. W. C. Rigby, Adelaide, South Australia. Melville and Mullen, Melbourne, Victoria.

BELGIUM, Brussels: E. F. Satchell, 86, Rue du Tabellion.

CANADA, Toronto, Ont.: Wm. Dawson and Sons, Limited, 87, Queen Street, East.

EDINBURGH: John Menzies and Co., Limited, Rose-street.

FRANCE, Paris: Boyveau and Chevillet, 22, Rue de la Banque. For Advertisements, Office de Publications Commerciales, 167 Rue Montmartre, Paris (2e).

GERMANY: Hermann H. Fromm, Potsdamerstr 105A, Berlin, W. 35. A. Twietmeyer, Leipzig.

GLASGOW: William Love, 221, Argyle-street. John Menzies and Co., Limited, West Nile-street.

INDIA, Calcutta: Thacker, Spink and Co. Bombay: Thacker and Co., Limited.

ITALY: U. Hoepli, Milan. Anonima Libraria Italiana, Torino. And any post office.

LIVERPOOL: Mrs. Taylor, Landing Stages.

MANCHESTER: John Heywood, 143, Deansgate.

NEW ZEALAND: Gordon and Gotch Proprietary, Limited, Wellington, Auckland and Christchurch.

NORWAY, Christiania: Cammermeyer's Boghandel, Carl Johans Gade, 41 and 43.

ROTTERDAM: H. A. Kramers and Son, Limited.

SOUTH AFRICA: Central News Agency, Limited, Head Office—Johannesburg; and Pretoria, Cape Town, Port Elizabeth, Bloemfontein, Durban, and various branches and bookstalls throughout South Africa. Wm. Dawson and Sons (South Africa), Limited, 29, Long-street, Capetown.

TASMANIA: Gordon & Gotch Prop'ty, Ltd., Launceston: Hobart.

UNITED STATES: For Subscriptions, New York: W. H. Wiley, 432, Fourth Avenue. For Advertisements: J. S. Allan, 30, Church-street, New York.


## CONTENTS.


| | PAGE |
|---|---|
| The Motor Ship "Margretian" with Beardmore-Speedwell Oil Engine (*Illus.*) | 791 |
| The Scientific and Industrial Research Department, 1922–23 | 793 |
| 250-Ton Dragline Excavator (*Illus.*) | 795 |
| The Mass Production of Railway Wagons | 797 |
| The Shipment of Locomotives to India (*Illus.*) | 802 |
| Royal Meteorological Society | 804 |
| Notes from South Yorkshire | 804 |
| Notes from Cleveland and the Northern Counties | 805 |
| Notes from the North | 805 |
| Notes from the South-West | 805 |
| Notices of Meetings | 805 |
| British Colonial Motor Trade | 807 |
| Workmen's Compensation Cases | 808 |
| Price or Quality Considerations when Purchasing Machine Tools | 808 |
| Notes | 809 |
| Literature | 810 |
| Books Received | 811 |
| Year-Books and Annuals | 812 |
| *Letters to the Editor.*—"Stresses in Bridges." "Powdered Coal for Raising Steam" | 812 |
| The Optical Society | 812 |
| Industrial Notes | 813 |
| Diagrams showing Fluctuations in the Prices of Metals from Christmas, 1892, to Christmas, 1923 | 814 |
| Universal Motor-Engine Stand (*Illus.*) | 815 |
| The Significance of the Notched-Bar Impact Test (*Illus.*) | 815 |
| Exhaust-Valve and Cylinder-Head Temperatures in High-Speed Petrol Engines (*Illus.*) | 816 |
| Catalogues | 819 |
| ENGINEERING Patent Record (*Illus.*) | 820 |


*Two-Page Plate.—THE MOTOR CARGO SHIP "MARGRETIAN" WITH BEARDMORE-SPEEDWELL OIL ENGINES.*


# ENGINEERING.

*FRIDAY, DECEMBER* 28, 1923.


## BRITISH COLONIAL MOTOR TRADE.

AT the present moment the chief preoccupation of our captains of industry is the encouragement and increase of trade with the British Colonies and Dependencies. For some years the importance of this field has been recognised in the motor trade which is now generally considered as being the third in magnitude in this country, but at present a far larger number of the cars made in Britain are sold in the British market. Foreign and particularly American private cars as well as commercial vehicles not only find a good market in England but they are still more successful in the Colonies, in many of which their sales largely exceed those of the British vehicles.

The probable reasons for this preference for cars of foreign material to those produced in the mother country may be roughly divided into—Firstly, price; secondly, suitability to the conditions of the country in which they are to work; and thirdly, facility in handling by the class of labour that will drive, and more particularly by that which will repair, the cars. For the first item protection within the Dominions may or may not tend to equalise the conditions; improvements in methods of manufacture and production will aid still further in meeting this side of foreign competition.

It is, however, in regard to the second of these three points that there appears to be the greatest difference between the foreign and the British car, and it particularly affects cars of those classes that have adequate power and carrying capacity as well as a low overall price, and therefore that appeal to the Colonial purchaser. Much has been written and discussed on the subject of the relative advantages of the large bore "woolly" engine and the small high-speed engine, and the basic rating formula for the motor tax has been blamed for the encouragement of the latter type of engine. But there are many other points that require consideration in the preparation of a design of car suitable for Colonial use that are not found in British practice. In the Colonies the car will be required to run from rail head over a possibly good road, then by a bad road rough and full of holes, followed by open country, alternating perhaps with stretches of field tracks having deep ruts; or it may have to run on a corduroy road, to cross land strewn with boulders and to ford shallow steams; at times it will be called upon to cross country flooded to a depth of several inches; on rough ground it may encounter deep mud-filled holes, and it should be capable of extricating itself from ordinary difficulties such as arise from wet clay, and fresh snow. In fact, it has to fulfil conditions much more closely resembling those that have hitherto been met by horse or mule traction than those to which the roads of this country are approaching. Nor is this all, the car may be called upon to run over snow-cleared roads at a temperature of 20 deg. or 30 deg. below freezing point, or it may be required to cross desert country in dry air exposed to the heat of a tropical sun; or again, it may have to work at several thousand feet above sea level in a greatly reduced atmosphere. These conditions do not occur in this country, at any rate generally. We have only at rare intervals cold approaching that of Canada, there are but few small sandy tracts to compare with the desert lands of Australia, for here the sun rarely induces boiling of the water in radiators even though helped by a following wind, and we have no mountain-roads high enough nor hills long enough, nor mountains themselves of sufficient magnitude to reproduce the conditions of New Zealand or the Transvaal. From this aspect the problem of the successful production of cars that can be depended upon to work reliably under such varied conditions is essentially one worthy of the study of the best technical automobile engineers in the country. It is the study of this problem, however, that has been the key to a great proportion of the success of the American car.

The preparation of the design for a new model of car requires a period of nearly a year, but the work produced as the result of such design will not satisfy the actual conditions unless the specification has been carefully drawn up by a technical man who has examined these conditions upon the spot, and has the designing capacity necessary for separating the essential from the non-essential features, as well as the breadth of view and experience necessary for arriving at the best possible compromise for requirements that sometimes differ and frequently oppose each other.

It might be thought that any large firm of motor manufacturers would be kept adequately posted by its sales department, and this would probably be the case were it possible to bridge the gap that usually exists between the selling agent and the manufacturing motor engineer. For this the selling agent is by no means wholly to blame. The British home market requires cars that can do well in reliability trials and in hill climbs, that are comfortable and easy to drive, and that are free from vibration, and are silent and economical. All of these points may be satisfied and the bulk of a year's production, except the percentage that has gone to the colonies, may prove satisfactory, and the sales agencies at home may have no serious defects to report or suggestions to make on the cars that have passed through their hands. On the other hand, the smaller and scattered agencies in the Colonies will deal with the problem at a date some months later when the design has been practically accepted in England, and it is late to criticise the model or to send suggestions relating to its shortcomings in meeting the Colonial conditions. The Colonial salesman is, moreover, confronted with the severe competition of vehicles constructed in the United States, a country that itself possesses all the limiting features suggested as representative of Colonial conditions. The American producer does not need to send a car across the ocean and thousands of miles away to find the various extreme conditions, but he can send the cars by rail and subject them, within the United States, to trials as severe as any Colonial purchaser could desire.

These are conditions with which protection has nothing whatever to do. A man will not buy a cheap car if it is unsuitable for the purpose for which he wants it or for the work that he knows it must perform, if, in the long run, he can obtain satisfactory service and better value from another, although its first cost be higher. Moreover, he must be assured that he can get spare parts without long delay and serious difficulty, that he can get stan-

dardised components such as ball-bearings to replace others that are worn out, that he can use the sizes of tyre or of details such as nuts and bolts that are not manufactured by the car builder without finding that they are of uncommon sizes that are not stocked in the Colony.

Examination of many of the cars at the recent Motor Show at Olympia reveals that in many respects very few of the British cars could hope to find a large and successful market in the Dominions. Amongst the points in which unsuitability to Colonial conditions appeared most general may be mentioned: insufficient clearance under the car from front axle to rear axle; inadequate allowance in the position of the wings for the full range of travel of the springs, particularly if the wheels should be fitted with over-size tyres for use on soft or sandy country; absence of protection of the magneto from water, whether in the form of rain, spray or snow that is drawn through the radiator, want of flexibility in the suspension of the engine and also of the radiator; weakening of frames by bad placing of holes drilled for step brackets or other parts of the coach work.

These visible features, however, do not by any means cover the whole field. It is necessary that the vehicles should be capable of crossing through a stream, under which conditions a large amount of water and spray is thrown up in front, and, unless special precautions have been taken in the design, not only will the magneto become wet and be put out of action, but all the other electric apparatus for starting, lighting and other purposes will be short-circuited. Water may also be drawn in through the air inlet of the carburettor, and in the absence of adequate protection it may even get into the petrol tank through the air-vent when a gravity feed is used.

The main question, however, that relates essentially to the particular kind of problem that the technical motor engineer should investigate on the spot, is the suitability of the present British or foreign vehicle for crossing rough ground. This point fortunately, is one that could be examined in this country and the result of such examination might well lead motor manufacturing firms to consider the advisability of sending their best experts to examine the existing Colonial conditions on the spot in the Colonies. A practical test is to lift one wheel off the ground till the other wheel on the same axle also leaves the ground; while the chassis and engine suspensions are subjected to these conditions at the front end of the car it should be ascertained: whether the engine will continue to run; whether the engine controls will continue to function both by hand and foot; whether the steering gear, the change gear and the brakes are still capable of being operated; and, finally, whether all these functions can be performed with the back axle similarly treated.

The third point for which expert investigation is required on the spot is that of driving and repairing. In preparing a design suitable for use under rough conditions it will be well to ascertain at first hand what treatment is meted out to American and other cars; whether gears are changed by the drivers as quietly as is commonly the case here; whether there is a preference for epicyclic gear change; whether pin-jointed cardan shafts are preferred to flexible couplings and if so, why? what height of body floor is found most suitable and what wheel-base best fulfils the requirements on the road. These matters are probably of far greater interest than an observed performance on Countisbury Hill or Dunmail Raise or a guarantee that the mileage will exceed 50 ton-miles per gallon of petrol on an ordinary give and take road in England, such as that from London to Brighton.

Finally, the equipment of local repairers, the supply of those spares that are most likely to be required, and the methods adopted by them for effecting minor repairs and adjustments to a car, where distances are great and transport becomes even more difficult while the car is laid up, are matters that can only be properly appreciated and taken into consideration in producing a good Colonial model by an automobile engineer who has himself had actual all-round experience, has added to this first-hand investigation in the Colonies, and is, therefore, capable of sound judgment.

## WORKMEN'S COMPENSATION CASES.

It seems to become more difficult every day to know when an accident is to be regarded, for the purposes of the Workmen's Compensation Acts, as having arisen out of, and in the course of, the injured person's employment. Last month the House of Lords held by a majority that a railway accident in which a miner was injured had not arisen, so far as he was concerned, in the course of his employment and that he was not entitled to compensation. The colliery company had arranged with the railway company for special trains for the conveyance of their workmen between their place of residence and the colliery. It was a term of the arrangement that the workmen released the railway company from all claims in respect of accidents. One of the men, while travelling on one of these trains, was injured through a railway accident. He was not bound to travel by the train; he could have come to his work in any other convenient way; and the House of Lords, reversing the decision of the Court of Appeal, held by a majority that the accident had not arisen in the course of his employment.

A few days ago another difficult case (Upton *v.* The Great Central Railway Company) came before the House of Lords, in which the question in dispute was whether the accident had arisen out of the injured man's employment. The man was a foreman labourer in the railway company's employment. He was sent by them from Guide Bridge to do some work some distance from Dunford Bridge Station. When he had finished the work he went back to Dunford Bridge Station to get a train back to Guide Bridge. It was a wet, windy day, and when the train came in he hurried across the platform to get into the train. He slipped and fell, and as a result injured his knee. Septicæmia set in, and he died. His widow claimed compensation. It could not be disputed that he was in the course of his employment at the time of the accident, because he was entitled to be paid for his time until he got back to Guide Bridge; but that was not sufficient unless the accident arose out of the employment. The County Court judge held that the accident did not arise out of the employment. This was affirmed by the Court of Appeal by a majority. The widow appealed to the House of Lords, and the House reversed the judgment of the Court of Appeal and held that the accident arose out of, and in the course of, the man's employment. So far as can be gathered from the report at present available, the real question in dispute seems to have been whether the accident was in any way caused by the employment. Obviously a person might slip on a railway platform whether he were employed or not; and in the case under consideration it seems to have been agreed that if the man had been careful he could probably have avoided slipping. Lord Haldane said: "The expression 'arising out of' no doubt imports some kind of causal relation with the employment, but it does not necessitate direct or physical causation." The legislature appears to have provided that the workman is to be compensated for injuries by accident, provided the accident arises out of the conditions under which he is employed; and if, in the course of the employment, the workman meets with injuries by an accident which has arisen directly out of circumstances encountered because to encounter them fell within the scope of the employment, compensation may be claimed. Lord Haldane apparently thought that the man was exposed to the risk of slipping on the platform, because his duty brought him there—in other words, his being on the platform and being exposed to the risk of slipping was a circumstance which it was within the scope of his employment to encounter. The other noble and learned Lords gave judgment to the same effect.

The unfortunate thing about workmen's compensation litigation is that there seems to be no finality about it. In some branches of the law an authoritative judgment provides a rule which applies to innumerable other cases; but in workmen's compensation law each judgment seems merely to alter the position of the debatable line without making it any clearer or in any degree more definite. In the new Act the Legislature has discretely refrained from attempting to define the meaning of the words "out of and in the course of the employment."

## PRICE OR QUALITY CONSIDERATIONS WHEN PURCHASING MACHINE TOOLS.

To obtain something for nothing is equally impossible in the machinery world as in any other sphere, unless, of course, that something be trouble. And the purchaser who wants quality—the best—in his machine tools must be prepared to pay for it. Very often it is hard to justify the difference in price between two machines of the same size and generally similar in type. The shop executives may recommend the higher-priced machine, their standpoint being the productive value on the class of work for which it is required, but the buyer cannot reconcile the extra cost. And such differences as are present are frequently difficult to explain in actual *l. s. d.* On the surface it would appear that a close co-operation between the purchasing agent and the technical executives should exist when such purchases are being made. The latter make their recommendations after considerable time and effort spent on investigation, but often other machines at less price appear to the purchasing department to be equal in size and appearance to the ones recommended, and the latter are purchased in too many cases as a result.

Steel, pig-iron, and similar commodities are purchased to given specifications. Bought under such definite guarantees price *can* be the deciding factor. That this does not apply to machine tools is readily evident, but in addition, machine tool makers know only too well that the point is not so fully appreciated as it should be, and that price consideration too often has pre-eminence. Some of the fixed production charges remain constant whether a high-priced or low-priced machine is installed, such as the operator's wages, amount of floor space occupied, and power consumption, though the better class machine may be able to show a slight economy in this latter direction. The real difference, then, and the real issue for decision is the relative productive values of the machines under consideration.

The purchase of a machine tool thus resolves itself into a purchase of productive capacity, or even of a firm's own production. New manufacturing schemes, plant extensions, or alterations in designs may call for new plant. But the bigger portion of the machine-tool maker's output is absorbed by the installation of machines to replace obsolete plant; in short, for the increased production and savings to be effected over existing methods and equipment. This consideration alone should be sufficient to show that quality and not price should be the deciding factor in the purchase. Especially in the present trade conditions, there is no likelihood of the builder asking an extortionate price for his machines. Competition demands that they be sold at the lowest possible price, representative of a fair profit on the production cost. Very often prices are quoted which barely cover overhead expenses, in the hope of creating goodwill and in the interests of future business. The result is that such difference as may exist between the prices of competitive machines can be justified in their quality by careful investigation. The same factor which keeps prices as low as possible also obviates to a great degree the inclusion of redundant features to act merely as "selling points." Such features as are incorporated should be introduced only in relation to the operations for which the tool is designed, and the production and works executives soon recognise any "extra" features which the builder may be tempted to include.

But what is this "quality"? Exactly what does it constitute? Even the "cheaper" machine may appear to have a number of desirable features, and superficially may even seem to compare favourably with the higher-priced tool. At the outset it has to be borne in mind that the purchase is for a long period, and by reason of the disastrous consequences which are inevitable from the choice and use of unsuitable plant, most careful deliberation is called for in the initial stages. The "quality" in question will invariably be found in refinements in design

and construction, the value of which are fully reaped in use, in continuous working, small repair bills, and few breakdowns. Careful weight distribution, to give the necessary rigidity against cutting thrusts without undue bulk, splined driving and gear-box shafts, judicious introduction of ball and roller bearings for moving members, to reduce power consumption and give easy and efficient running, the machining of gears with accurate tooth form from high quality steel blanks, proper lubricating provision, stringent factory inspections, the use of first-class materials only, effective locking provisions and ample bearing surfaces for travelling members, these and other similar features will enable the better class machine to stand up to higher speeds and coarser feeds without trouble, and to give consistently higher output than the other types. The profit on production with the new machine is certainly an important factor, but in addition to this there must be considered the amount of "trouble free" working and small repair expenses in connection with the high quality tool, which invariably repay, with interest, the small extra initial cost. If the higher-priced machine is desired, but the cost such as will not be sanctioned, possibly the maker whose design is favoured will be asked to put in an alternative proposition more in line with the other quotations received. A simpler type of machine will then be put forward at a correspondingly lower price. Possibly this latter design may incorporate high-class materials, &c., but there is sure to be some "quality" reduction also, so that such a tool would not be capable of the same output as the initial proposition.

When purchasing labour to run the shop the executive seeks the best available, desires the highest grade of skill which he can find for the various jobs. In a similar manner and for exactly the same reasons he should seek the best plant for his purpose. If the shop executive is considered a thoroughly sound official, capable of exercising correct judgment, surely his recommendations should carry weight with the purchasing agent instead of the latter buying on price only.

The deduction from these considerations would seem to be that it is incumbent on the machine-tool maker to produce the best possible tools, equally as on the buyer to recognise that "quality" and not initial cost should be the premier consideration in his decision. And if the builder embodies in his machines the necessary operative convenience and ample power reserve for high speed duty, ensures that his skilfully-designed mechanisms are built with every care, thoroughly and rigorously tested, accurate in alignment, &c., he should be entitled to a fair price in return, one that will show a reasonable profit on his labours. This must essentially obtain or he will have to go out of business. As already observed, however, many prices are cut to the limit in the endeavour to introduce new machines at the present time and to cater thereby for future business, but when trade becomes more normal the new prices will have to cover present losses resultant upon this price cutting. To expect that two machines of entirely different grades of "quality" should be selling at the same price is therefore totally unreasonable.

The bigger firms of machine-tool builders are, to a certain extent, able to design their machines from the point of view of efficiency when in commission, without having to consider the buyer who looks at price only. When trade is moving briskly, this policy can be rigidly adhered to, but in times like the present there is very often the necessity to run a series of cheaper machines to obtain such orders as are likely to be decided on price, thus bringing them in a position to compete with the "cheaper" standard designs in which some firms seem to specialise, catering for the price buyer whom they know quite well does exist. Possibly the larger firm is somewhat reluctant to sell these simplified designs, for they know that each machine or group of machines is dependent on the others of a plant to ensure smooth production progress, and that a poor machine may hamper output seriously. But they require orders to keep their shop going. A point of distinct interest here, an alternative to this offering of simpler designs, is to embody the very latest productive features, or one special feature, without any extra sum on the standard price of the machines on which such features are to be embodied. This places the machine in question far ahead of its competitors for the slight extra cost. Perhaps the actual production cost may be no more with this feature embodied. But the builder has had to bear the cost of experimenting, and the benefits of the long experience and painstaking research which has led to these improvements are to the ultimate benefit of the user. And surely the maker is entitled to some return on his efforts, and included in the selling price should rightly be some return for this outlay, otherwise a concession is being offered to the customer when no extra charge is made. The latter course, where possible, would appear to be preferable to a line of simpler machines, which have a tendency to damage a reputation for high grade tools. In normal times, even though, as mentioned above, the actual production cost may be the same, an extra price would be required for this particular feature or features, and quite rightly so. Ultimate cost and not first cost is the prime factor when purchasing, and the machine-tool maker who follows the policy of keeping to the best is to be admired. At least one good result of the trade slump has been to show many purchasers that so-called "cheap" machines do not pay, and the slight extra initial cost for a really high-class tool is well worth while.

There is a field of utility for practically every machine tool made, and the judgment of the user should determine the most suitable machine for the work to be executed. In terms of production service and in a valuable well-balanced "production" plant, the purchaser who investigates quality as well as price is able to justify his decision, and show definite evidence of true and keen discrimination.

## NOTES.

### Shrinkage and Cavities in Iron Castings.

In continuation of some experiments by Wüst and A. Diefenthäler, Messrs. O. Bauer, K. Sipp and E. von Gienanth have, on behalf of a committee of foundrymen, been inquiring into the relations between the formation of cavities in cast iron and the composition and pouring temperatures of the material. They started from a Swedish charcoal iron containing 3·35 per cent. of total carbon, to which they added increasing percentages of silicon, manganese, phosphorus and sulphur. The test pieces were bars of 90 mm. by 85 mm., 900 mm. long, that is, 3-ft. bars about 3½ in. square, widening near the one end into a flat knob, about 8 in. in diameter. Two bars were poured of each mixture; the one at about 1,000 deg. C. and the other at 2,000 deg. C. Temperatures were determined, with the aid of thermocouples, in the bath and on the outside and in the inside of the bars; volume measurements were made with the aid of a device due to Diefenthäler and Sipp; density, bending and micrographic tests were also made. When the specimen had cooled, the surface cavities were first determined with the help of wax, the knob being split to measure the internal cavities. Blowholes were, however, also found in the other portions. The external cavities were surface depressions, sometimes of funnel shape; the irregular internal cavities were generally not visible from the outside. The experiments, dealt with in *Stahl und Eisen*, of September 27, confirm the observation that white iron shrinks more than grey iron. All the specimens began in the first instance to expand as solidification set in; this expansion was diminished by the addition of silicon and phosphorus, whilst manganese and sulphur had no distinct influence in that respect. The subsequent total shrinkage decreased with increasing silicon and phosphorus percentages, which would facilitate the segregation of graphite; manganese and sulphur favoured shrinkage probably because they impede this segregation. As regards external and internal cavities it was found that hot pouring leads to the formation of external cavities and cold pouring to internal cavities. Hot-cast specimens showed on the whole larger cavities than cold-poured specimens. Taking both kinds of external and internal flaws together it may be said that decreased shrinkage and decreased cavitation run parallel. In the density variations the differences between hot and cold pouring were less marked than in the shrinkage. External cavities may be avoided by giving the piece suitable shape and position in the mould. In relatively-cold castings the formation of a hard crust prevents the yielding of the outer layers and favours the formation of internal holes; that tendency is diminished by supplying supplementary pouring runners. Comparative tests, made by Wüst and Schitzkowski, with originally-pure iron, free of carbon, agreed in the main with the conclusions arrived at, but showed also once more that experiments with binary alloys are not decisive for multiple alloys.

### Coloration of Diamonds by Radium Radiations.

A research conducted by S. C. Lind and D. C. Bardwell, of the United States Bureau of Mines, makes it pretty clear that all diamonds will permanently be coloured when exposed to radium radiations and that the colour assumed will generally be green, but leaves the question of the nature of the change obscure—suggestively obscure, one might say, considering the importance of these problems. Since all minerals seem to be coloured by the penetrating radiations of radium, *i.e.*, by the $\beta$ and $\gamma$ rays, and not by the $\alpha$ rays, as the same experimenters had observed in a previous research on thermophosphorescence, it was first investigated whether diamonds exposed for a month to the penetrating radiations passing through a glass tube of a wall thickness of 0·5 mm. or 1 mm. would undergo any colour change. No effect was observed. But when the diamonds—specimens from the Cape and from Brazil—were sealed within the glass tubes containing radium chloride and placed in the salt or on the top of the salt, the crystals assumed a grass-green tint in the course of 30 days. On longer exposure a deep emerald green was developed. The effect therefore seemed to be due to the $\alpha$ rays, which the glass wall of the salt container would not allow to pass through, and not to be caused by the more penetrating rays. But $\alpha$ rays can only penetrate into diamond to a depth of 0·001 in., while the coloration seemed to be deep-seated and to go right through the crystal. If the coloration were due to $\alpha$ particles, on the other hand, radium emanation should be more effective even than the salt, and that was confirmed by experiments. At the same time a novel curious observation was made. "Carbon spots," black specks, surrounded by a brownish halo, developed in most of the specimens when exposed to emanation, but not in any specimens treated with the direct radiations. Black graphitic spots are sometimes found in natural diamonds, but they had never been artificially produced before. The artificial black spots could not be eliminated again by any chemical means, except by heating the diamonds in air to red glow, whilst heating to 500 deg. C. for half an hour or less (at higher temperature) completely destroyed the green colour, restoring the original colour, which was yellow or brown in some cases, or colourless condition. If the artificial black spots had been caused by "germs" of graphite, that heating could not have reconverted the graphite into diamond. The black spots might, however, be due to enclosures of carbon monoxide (possibly also dioxide) which the radiations would decompose into free carbon and oxygen, while the intense heating would make the carbon and oxygen recombine. But all that is very uncertain. The colouring observed by Lind and Bardwell was always green, whilst other experimenters had spoken of other tints. Whether or not the colour is limited to the surface layer remains doubtful. Crookes had, in a few cases, removed the colour by grinding off the surface of the diamond exposed to the radiations; that grinding would liberate heat, however, and the effect might be thermal. Gem experts declared that the colouring extended throughout the crystals; a few diamonds, coloured green by the radiations, were broken up and the fragments appeared green all through; but the possibility of reflection from coloured surface layers was difficult to exclude.

Mining Surveys in Syria.—The British Acting-Consul-General at Beyrout has forwarded to the Board of Trade a copy of a circular (in French) regarding the presentation or renewal of demands for permits for mining surveys in Syria and the Lebanon. All such demands must be submitted before the 31st. inst.

# LITERATURE.

*Practical Mathematical Analysis.* By H. Von Sanden. Professor of Mathematics at the University of Clausthal. Translated by H. Levy, M.A., D.Sc., Professor of Mathematics, Imperial University of Science and Technology. London: Methuen and Co., Limited. [Price 10*s.* 6*d.*]

Many treatises have been prepared by mathematicians with the avowed object of removing the inconveniences arising from the defective preliminary training of engineers and others, and of equipping them with the material that they should have acquired at schools and technical colleges. These supplementary courses are generally unsatisfactory, for the incapacity or unwillingness of the pupil to acquire a mastery of the elementary principles can rarely be overcome by efforts later in life. Considerable acquaintance with these substitutes for early training, makes us more ready to welcome the appearance of a book, whose main object is to make the work of the pure mathematician available to the practical scientist, not by whittling away difficulties or impairing the accuracy of the reasoning, but by providing legitimate methods that give reality to analytical results. These may not increase the analytical power of a student, but they enable him to translate derived results into terms that are clearly appreciated and are readily applicable. Such operations are the more necessary because, as the author points out, there is a growing tendency to regard a problem as solved when the proof of the existence of a solution has been demonstrated. As mathematical notation becomes more elaborate, and the need for the translation of formulæ less necessary for the initiated in particular cases, all that is considered necessary is the construction of the differential equations governing the process under consideration. The practical side of the solution is regarded rather contemptuously, as an eminent professor expressed himself to the writer of this note: "he would not work sums." All should remember, however, that the construction of a lunar or planetary theory is of little service to the practical astronomer, except the theory be put in the form of numerical tables. Similarly, the qualitative discussion of the functions contained in an integral is not so satisfactory as a quantitative numerical expression for the solution, whether it furnishes the values of the dependent variables for all material values of the independent variables, or as a curve, represents the required function in a graphical form relative to a system of co-ordinate axes.

When the mathematician does stoop to apply precise arithmetical treatment to the problem he discusses, he is apt to indulge in a degree of accuracy that leaves the engineering student helplessly behind. We have seen sums worked out to the seventh decimal place, when the first significant integer may not have been correct. Every practical engineer knows that where the original data lack precision, drawing, intelligently planned and accurately finished, gives a sufficiently exact solution, and that to apply the more rigorous rules of arithmetic is a sheer waste of time. This apparent accuracy is an obsession with some, and the author recognises that the correct estimation of the degree of precision to be attained by the use of alternative methods of procedure may constitute a very real difficulty. To him in any given case, the choice is narrowed by applying the test, that the method to be selected is that which provides the requisite degree of accuracy in the shortest time.

Herein is raised the whole issue of approximate solution, whether by graphical or mechanical means, and the legitimate field for such application. The growing favour with which the application of mechanical methods to arithmetical operations is regarded, is sufficiently indicated by the increasing number of suitable apparatus on the market. The theory of some of these is well described, beginning with the slide rule, used imperfectly by the many but efficiently by few—certainly the writer of this note would not care to be asked to demonstrate the utility of the device by solving a cubic equation with its aid; multiplying machines, whose details grow simpler, as the results become more trustworthy; planimeters; direction scales; and a host of other appliances appeal as labour-saving devices to those who dread the multiplication table, or its expansion in the form of logarithms. Finally, we approach the science of nomography, mentioned but not discussed by the author, wherein if no actual graphical calculation is carried through, yet a substitute is provided for the tabular representation of a function of several variables, opening up a wide field of usefulness as the process becomes better known and practised. It may be conceded, that the theory of the instruments presents no difficulty to the competent mathematician, but the conclusion is not warranted that the mathematician will use such devices when the occasion arises, and that on that ground systematic instruction in mechanical analysis is unnecessary, and without educational value. Whatever method is used requires considerable manipulative skill and much practice before the best results can be obtained with ease and certainty. We are grateful to the author for insisting on the necessity of acquiring proficiency by frequent repetition of simple processes, and for recommending systematic arrangement in the conduct of arithmetical calculations.

The mathematical analysis properly so-called begins with the application of Horner's scheme for the numerical solution of algebraic equations and analogous problems, such as the determination of the value of a rational integral function for complex values of the argument, and then used to obtain the complex roots of the function when equated to zero. The application of the graphical method to Horner's scheme presents some novel points which will be followed with interest. In the following chapters on interpolation of a rational integral function, the methods of Bessel are generally recommended, and these perhaps are less appreciated by one who has always used the older, if less convenient form, of Newton, when requiring the value of a function for such values of the variable quantity as are not provided at sight. The remarks on the estimation of the error might have been set out more fully. It is intimated that the extent of the error may be minimised by diminishing the interval in the tabulation or by the inclusion of differences of a higher order. There is no suggestion of which is the more judicious course, and it must be admitted that in practice, the values of the function are not exact; and consequently the differences of a high order are very sensibly effected by such errors. Generally we think it is agreed that that greater accuracy is attained by interpolating between sensibly exact values of the function than in computing new values *de novo* with the view of reducing the interval, especially if the new values introduced are subject to errors of the same order as the original quantities. The argument as stated merely serves to show that greater accuracy cannot be expected in the interpolated, than existed in the original. This goes without saying, but as the higher differences tend to disappear with the insertion of intermediate values, the regularity of the table of differences ceases to be a criterion of accuracy.

A chapter on mechanical quadrature is particularly interesting owing to the ingenious application of Simpson's rule, and of Gauss' method of integration, while later the employment of graphical integration to the determination of the remainder in the Taylorian expansion of an analytic function brings fresh interest. Most of us are content with making a mental estimate, or it may be omitting to make any estimate, and therefore it is desirable to have the actual representation of the error itself brought under the eye, which may be delineated in graphic form by means of a curve derived by a series of graphical integration.

In another section, we are introduced to a rigorous method of deriving normal places employing the term in general use in this country. Where observations are plotted to scale it is frequently found that no regular curve can be drawn through the discreet points representing the observations. Any attempt to fit the function to the given values is then hopeless, and it is preferable to draw a curve as evenly as possible among the points and to derive from the curve a rational integral function. The method devised for the substitution, or the correction, to the eyedrawn curve is elegant, but apparently a lengthy operation. A simpler method of smoothing due to Runge, is that generally followed by meteorologists which amounts practically to the substitution of the mean of three or five neighbouring ordinates instead of the single ordinate.

The last three chapters are devoted to the solution of equations, algebraic and transcendental, whatever form the roots may assume. Here we meet with the familiar equations of condition, and the derivation of the normal equation in which the number of unknowns is reduced to the number of independent equations. In effecting a numerical solution, the method of multiplying each successive equation by a coefficient that makes one unknown disappear after subtraction is recommended, though it is hard to see that the method possesses any advantage over the usual scheme of dividing each equation by $a_1$, $a_2$ . . . $a_n$, so that each equation has a coefficient of unity, and the unknown is eliminated on substraction. From the way the problem is approached there is no need to discuss the assignment of "weights" and the method applies only to linear equations. For the solution of algebraic equations of a higher degree, in addition to the method of successive approximation, another process is given, that of Graeffe, which we believe, is rarely used in arithmetical work. Its main feature consists in deriving other equations whose roots, are the eighth, sixteenth powers, &c., of the roots of the given equation, the roots being necessarily more separated as the powers increase. In the example given, the thirty-second power is used, and the result is very satisfactory.

We should like to give further instances of application, but perhaps enough has been said to show that the work is deserving of consideration by the practical mathematician, who wishes to give his results in a concrete form, readily understood by those interested. Also the treatise does much to remove the reproach attaching to the working of sums and illustrates the object Gauss and Runge had at heart in the development of the higher arithmetic. The translation seems to have been very ably made, and Dr. Levy has, moreover, increased the usefulness of the work of Von Sanden, by adding a number of original examples to assist the progress and test the proficiency of the pupil.

---

*Clouds and Smokes: The properties of Disperse Systems in Gases and their Practical Applications.* By William E. Gibbs, D.Sc., with a foreword by Sir Oliver Lodge, F.R.S. London: J. and A. Churchill, 1924. [Price 10*s.* 6*d.* net.]

The scientific journals report from time to time the results of inquiries by various committees into the nature and amount of the finely-divided particles that exist as impurities in the atmosphere of large towns. But this is only a part of a much larger problem, that concerns itself with the behaviour of disperse systems in a dispersion medium. There has been wanting a comprehensive survey of the entire subject that deals with the physics of the problem. Dr. Gibbs has supplied this want, and in the words of Sir Oliver Lodge, who has furnished a recommendatory foreword, he "has assimilated and made accessible a great part of the information procurable, and by giving copious and exact references, has enabled students to refer on special points to the original authorities." This is no slight service to render to the public, who are apt to disregard the many ways in which dust may effect the welfare of the nation generally. As a factor of importance in industry, the effects of dust are more obvious, for the collection of deleterious particles in manufactories may prove injurious to the health of the workpeople or become a constructive loss on the undertaking. This two-fold aspect of dust, its origin and distribution, with its bearing on physical theories on the one hand, and the attempts to overcome its evil influence on the other, naturally divides the book into two parts. In the first is traced the mechanical disintegration of matter overcoming the forces of cohesion. In dispersion processes, the mechanism is easily followed, but the action of condensation involving the presence of nuclei for the formation of particles is not so obvious, particularly the influence of the character of these nuclei, whether positive or negative gaseous ions, smoke particles, or other material fragments.

The main interest centres in the sufficiency of molecular physics, and the atomic theory of matter to explain the varied and complicated phenomena connected with the condensation of vapours *in vacuo*

and in gases, as well as the action between gases. The atomic and kinetic theories do not stand in any need of support, but the complete harmony disclosed between apparently unconnected phenomena adds to the strength of the evidence, in favour of recent hypotheses. The absolute uniformity of Nature is revealed. Every part and every movement fits in a definite and invariable way with other parts and other movements. The agreement of the Brownian movements with the kinetic hypothesis may seem very remotely connected with the presence of fogs and smoke in our atmosphere, but they are all part of one tale which nowhere contradicts itself. This uniformity of law enables the inquiry into the behaviour of finely divided matter, generally grouped here under the name of aerosols, to be followed with great minuteness with the deduction of trustworthy inferences. The number of workers on the subject is large, and an extensive and varied literature has been sifted by the author with great success. The mechanical, thermal, optical and electrical properties of aerosols are discussed with completeness. The results whether of experiment or deduction are equally interesting, and nowhere more conspicuously than in the examination of the flocculation of metal vapours. The methods of investigation in any inquiry are well described, and for many purposes simple apparatus gives ample opportunity for collecting statistical facts, and provides material of great assistance. The chemical and physical examination of aerosols collected by methods of deposition, filtration and precipitation, might well occupy the attention of amateurs, who could collect abundant material for microscopic examination and chemical analysis. Each sample gives only an approximation to the total amount of suspended matter in the atmosphere, and many such examples are needed for a correct average.

In the second part of the book in which is discussed the industrial treatment of fumes and dusty gases, the interest changes but by no means diminishes. Many will be surprised to see in how many branches of industry, and in how many ways the presence of a dispersed substance enters and declares itself, either in the atmosphere or in another dispersion medium. The size of the particles first arrests attention, because on its mass depends its chance of settling under the influence of gravity. The relative motion of the particles to that of the medium will also determine the rate of falling. Treating the particles as spheres, it is found that except the diameter of the particle exceeds $10^{-3}$ cm., the particle will not settle in still air or so slowly that the least upward movement of the air will carry it up again. With diameter less than $10^{-5}$ cm., the impacts of the gas molecules drive the particles about in ceaseless Brownian motion and the force of gravity has no control. The term of "dust" is usually applied to the large-sized particle, and these fall with increasing velocity; "clouds" to the intermediate class that fall in still air with constant velocity according to their size, and "smokes" the smallest known particles that will not fall at all in still air. Tobacco smoke may be regarded as a type of this last class.

It is not possible to enumerate all the causes that give rise to the dispersed substances, but industrially the more important are due to the condensation of vapours of metals, or of metallic compounds that are formed in the hottest parts of the smelting furnace, and condense in the fume as it leaves the furnace. Chemical action between metallic vapours and the furnace gases may operate to form compounds that are not volatile at the temperature of the furnace, or are volatile in the furnace but condense as the former passes away and cools. Mechanical disintegration from grinding is evidently a source of dust particles, and in some cases substances are manufactured in powder form by being dispersed in gas and subsequently collected.

However produced, most, if not all, of this scattered material is obnoxious and has to be removed or rendered harmless. Fortunately, as a rule, when the amount of suspended matter in the fume is sufficient to become obnoxious it will pay for recovery, and this is particularly noticeable in the metals, copper, silver, tin, arsenic and mercury. The fume may contain a valuable by-product as potash in blast-furnace gas and in cement dust. During the war when potash could not be procured from Alsace, these sources proved very remunerative. Or the material may be explosive, as in the case of mills and mines, where the fine particles are caught up in the air and become very explosive on ignition. Quantities of 35 grammes of flour, or 30 grammes of coal dust, per metre, may be a very real source of danger, and this fact alone is sufficient to emphasise the need of examining the distribution and behaviour of the disperse phase arising in industrial conditions.

The method of treatment must necessarily vary according to the character, composition and temperature of the gases, the physical and chemical nature of the suspended matter and the object of recovery or removal. But all methods are limited by the operation of the physical laws that have been examined. For instance, the separation of the dust particles may be facilitated by retarding the rate at which the gas or fume is moving. This plan is the foundation of the scheme of settling chambers, in which the object is to reduce the velocity of travel to 6 ft. per second or less, at which rate dust particles will separate as in still air. Another plan is to shorten the vertical path that has to be traversed by the particles. By introducing much shelving in the dust route, the distance the dust has to fall is reduced to a few inches, and disturbing upward currents of air are practically impossible. In some scrubbing machines the gas is passed through perforations of small diameter, with the view of forcing the particles into contact and producing a kind of flocculence. Or the particles may be loaded with water, when they become heavy enough to be acted upon by gravity. There are many variations of these methods, but no new principle is introduced. The method of electrostatic precipitation, due in a great measure to the laboratory experiments of Sir Oliver Lodge, utilises well-known principles in a very interesting manner. Laboratory work led the way in suggesting plans which failed only for want of sufficient voltage, and Sir Oliver looks with pride and amazement on this child of his own brain, working with a potential of hundreds of thousands of volts, giving a continuous current of sparks, and by the aid of great electrified chambers clearing vast quantities of dust from blast furnace gas. And he adds with the knowledge and generosity of a great scientist "The step from a laboratory experiment to a really practical and commercially continuous process is undoubtedly a great one, and the credit for it belongs to others than myself."

We have not space to enter into the part dust plays in meteorological phenomena or to follow the methods of utilisation of substances in a finely-divided condition in some of the operations of industry, as for example the preparation of metallic powders in pigments. It may be fervently hoped, however, that the dissemination of toxic smokes in warfare or the creation of dense vapours to hide naval operations, may become a lost art. The study of the minute particle has led to many useful applications in industry, and illuminated many problems in pure science, how many and in what directions we had not fully grasped till we saw the systematic arrangement that Dr. Gibbs has placed before us. "I commend the book," says Sir Oliver Lodge, "to the notice of practical engineers and of workers in pure Science." With this recommendation we would respectfully associate ourselves.

## BOOKS RECEIVED.

*Sands and Crushed Rocks.* Vol. I, *Their Nature, Properties and Treatment.* Vol. II, *Their Uses in Industries.* By ALFRED B. SEARLE. London: Henry Frowde and Hodder and Stoughton. [Price 52*s.* 6*d.* net, two volumes.]

*Mechanical World Year Book*, 1924. Manchester and London: Emmott and Co., Ltd. [Price 1*s.* 6*d.* net.]

*Das elektrische Feruschen und das Telehor.* By DIONYS VON MICHALY. Berlin: M. Krayn. [Price 6*s.*]

*Department of Scientific and Industrial Research. British Association for the Advancement of Science. Fifth Report on Colloid Chemistry and its General Acid Industrial Applications.* London: His Majesty's Stationery Office. [Price 2*s.* 6*d.* net.]

*Unterbau.* By W. HOYER. Berlin: Julius Springer. [Price 1·95 dols.]

*Werkstaffprüfung für Maschinen-und Eisenbau.* By Dr. G. SCHULZE and Dipl. Inj. E. POLLHARDT. Berlin: Julius Springer. [Price 1·90 dol.]

*Department of Overseas Trade. Report on the Commercial Situation in Indo-China, September*, 1923. By F. G. GORTON and H. F. C. WALSH. London: His Majesty's Stationery Office. [Price 9*d.* net.]

*The Middle Process of Cotton Mills.* By THOMAS THORNLEY. London: Scott Greenwood and Son. [Price 15*s.* net.]

*Aeronautical Research Committee.* Reports and Memoranda No. 877. *Tests of R.A.E. Gear Wheel Type Petrol Pump.* By the Staff of the Royal Aircraft Establishment. [Price 6*d.* net.] No. 878. *Phase Setting of Engine Indicators.* By H. Moss, D.Sc., and W. J. STERN, B.Sc. [Price 4*d.* net.] London; His Majesty's Stationery Office.

*United States Geological Survey. Mineral Resources of the United States.* 1: 6 *Arsenic in* 1922. By V. C. HEIKES and C. F. LOUGHLIN. 1: 11 *Quicksilver in* 1922. By F. L. RANSOME. *With a Supplementary Bibliography.* By ISOBEL P. EVANS. 11: 8 *Magnesium and Its Compounds in* 1922. By J. M. HILL and G. F. LOUGHLIN. 11: 9 *Strontium in* 1922. By G. W. STOSE. 11: 11 *Fullers Earth in* 1922. By J. MIDDLETON. Washington: Government Printing Office.

*United States Geological Survey.* Bulletin No. 748. *The Twenty-mile Park District of the Jampa Coal Field. Routt County, Colorado.* By M. R. CAMPBELL. [Price 20 cents.] Water Supply Paper No. 506. *Surface Water Supply of the United States*, 1919-1920. Part VI. *Missouri River Basin.* [Price 35 cents.] No. 515. *Surface Water Supply of Hawaii, July* 1, 1918, *to June* 30, 1919. NATHAN C. GROVER, Chief Hydraulic Engineer. [Price 15 cents.] Washington: Government Printing Office.

*Pulverised and Colloidal Fuel.* By J. T. DUNN, D.Sc., F.I.C. London: Ernest Benn, Limited. [Price 25*s.* net.]

*Department of Oversea Trade. Report on the Economical Conditions in South Africa, July*, 1923. By W. J. WICKHAM. London: His Majesty's Stationery Office. [Price 1*s.* 6*d.* net.]

*Der Radio-Amateur.* By Dr. P. LERTES. Dresden and Leipzig: Theodore Steinkopff. [Price 6*s.*]

*Wellington Harbour Board. New Zealand Year Book*, 1924. Wellington: Offices of the Harbour Board. Price 2*s.* 6*d.*

*Second Annual Report of the Federal Power Commission, June*, 20, 1923. Washington: Government Printing Office.

*Design of Concrete Structures.* By L. C. URQUHART, C.E., and C. E. O'ROURKE, C.E. First edition. London: McGraw-Hill Publishing Company, Limited. [Price 20*s.* net.]

*Stresses in Framed Structures.* Edited by GEORGE A. HOOL, S.B. and W. S. KINNE, B.S. First edition. London: McGraw-Hill Publishing Company, Limited. [Price 25*s.* net.]

*The Design of Diagrams for Engineering Formulas and the Theory of Nomography.* By LAURENCE L. HEWES, B.Sc., Ph. D. and HERBERT L. SEWARD, Ph.B., M.E. First edition. London: McGraw-Hill Publishing Company, Limited. [Price 25*s.* net.]

*Handbuch des Dampflokomotiobanes.* By Dr. MARTIN IGEL. Berlin: M. Krayn. [Price 15*s.*]

*Site Planning in Practice. An Investigation of the Principles of Housing Estate Development.* By F. LOUP-TRETH THOMPSON, B.Sc. London: Henry Frowde & Hodder & Stoughton. [Price 16*s.* net.]

*Transactions of the Institution of Naval Architects, Vol. LXV.* 1923. Edited by R. W. DANA, O.B.E., M.A., M.Inst.C.E. London: Offices of the Institution and Henry Sotheran & Co.

*The Utilisation of Low Grade and Waste Fuels.* By W. FRANCIS GOODRICH, M.B.E. London: Ernest Benn, Limited. [Price 42*s.* net.]

---

POWDERED COAL IN METALLURGY.—According to *The Iron Age*, New York, the Dayton Malleable Iron Company had decided to use powdered coal in connection with its melting furnaces, of which there are 14 at its plants at Buffalo, Dayton and Ironton. The Fuller-Lehigh Company, Fullerton, Pa., is to provide the equipment and apparatus. The use of powdered coal may be extended to the 84 annealing furnaces in the three plants, but attention will first be given to expediting the installation for the melting furnaces.

VANADIUM IN PERU.—The vanadium mines near Casapalca, in the Peruvian Andes, which were closed down in 1921, have resumed operations, says Consul C. E. Guyant, Callao, in a report to the Commerce Department, quoted by *Industrial and Engineering Chemistry*, Washington. It is expected that as soon as everything is in running order there will be a monthly output of approximately 1,000 tons. The ore runs from 25 per cent. to 30 per cent. of vanadic acid, and will be shipped to the United States for reduction.

CANADIAN NATIONAL RAILWAYS EXTENSIONS.—Despite scarcity of labour which retarded the completion of the work, a large number of terminal improvements have been carried out by the Canadian National Railways at Montreal, says *The Canadian Engineer*. This work included extension of the west receiving and departure yard at Turcot, which will provide additional facilities, extension of stalls at the Turcot roundhouse in order to accommodate the very large locomotives of the "6,000" class, the erection of a shed at Richmond-street to facilitate the handling of fast train goods, additions to the trackage at Windmill Point to speed up the handling of coal cargoes, and improvements at the Victoria Bridge approach. In addition, there has been installed at Point St. Charles the most modern car-weighing scale in the country, whilst at Bonaventure there has been placed in commission a fleet of three electric tractors and 25 trailers for the more efficient and speedy handling of baggage to and from the trains.

## INDUSTRIAL NOTES.

The Ministry of Labour states that employment showed a slight improvement, on the whole, during November. Among workpeople insured under the Unemployment Insurance Acts, in Great Britain and Northern Ireland, the percentage unemployed was 11·5 on November 26 compared with 11·7 on October 22, and with 11·7 on September 24. At the end of November, 1922, the corresponding percentage was 12·7. Among members of Trade Unions from which returns were received the percentage unemployed was 10·5 at the end of November, compared with 10·9 at the end of October. The total number of workpeople registered at the Employment Exchanges as unemployed on November 26, in Great Britain and Northern Ireland, was approximately 1,257,000, of whom 945,000 were men and 240,000 were women, the remainder being boys and girls. On October 29, the total was 1,296,000, of whom 970,000 were men and 246,000 were women. Employment was good in coal mining and in the tinplate and steel sheet trades; it was fairly good with skilled workmen (except painters) in the building trades and in certain sections of the metal industry, and fair in the brick-making, woodworking, printing, jute and leather trades. In most of the other large industries it was slack or bad. The principal industries showing an improvement were pig-iron manufacture, iron and steel manufacture, and the cotton trade.

---

The upward tendency in wages, which had been in evidence since July, was checked in November, owing mainly to reductions in rates of wages in the coal mining industry. In the industries for which statistics are available, the changes in rates of wages reported as having taken effect in November resulted in an aggregate reduction of about 150,000*l.* in the weekly full-time wages of nearly 950,000 workpeople, and in an increase of nearly 36,000*l.* in the weekly wages of over 400,000 workpeople. In the coal mining industry, reductions in rates of wages were made in Northumberland, Durham, Yorkshire and the East Midlands, the Forest of Dean, South Wales and Scotland, the amount of reduction varying from about 3 per cent. on current rates in Northumberland and Durham to over 9 per cent. in South Wales and Scotland. There were also reductions in the wages of iron ore miners and blast furnace workers in Cumberland, and of iron puddlers and millmen in the North of England and West of Scotland. The increases in wages occurred mainly in the metal and clothing trades and in the public utility services, and in most cases resulted from the operation of sliding scales by which wages are regulated in accordance either with selling prices or with the cost of living. Under such arrangements there were increases in the wages of steel smelters, tinplate workers, tramway workers, and in those of furniture trade operatives and employees of local authorities in London. Up till the end of November the changes in rates of wages reported to the Labour Department during 1923 had resulted in a net reduction of nearly 480,000*l.* in the weekly full time wages of 3,000,000 workpeople and a net increase of nearly 170,000*l.* in those of 1,200,000 workpeople. In the corresponding period of 1922 there was a net reduction of nearly 4,200,000*l.* in the weekly full time wages of over 7,500,000 workpeople, and a net increase of nearly 11,500*l.* in the wages of about 74,000 workpeople.

---

On December 1 the average level of retail prices of the commodities taken into account in the statistics prepared by the Ministry of Labour (including food, rent, clothing, fuel, light and miscellaneous items) was approximately 77 per cent. above that of July, 1914, as compared with 75 per cent. a month ago and 80 per cent. a year ago. For food alone the corresponding percentage for December 1 was 76, as compared with 73 a month earlier and with 78 on December 1, 1922.

---

The number of trade disputes involving stoppages of work, reported to the Department as beginning in November, was 38. In addition, 15 disputes which began before November were still in progress at the beginning of the month. The total number of workpeople involved in all disputes in November was approximately 54,000, as compared with 56,000 in the previous month and 9,000 in November, 1922. The estimated aggregate duration of all disputes during November was about 1,016,000 working days, as compared with 1,167,000 days in October, 1923, and 68,000 days in November, 1922. The dispute involving members of the United Society of Boilermakers and Iron and Steel Shipbuilders in federated shipyards, which had been in progress since April 30, terminated on November 24.

---

The National Wages Board has issued its report on the railway companies' claims for a revision of wages and working conditions and on those of two unions, the enginemen and the clerical staffs' societies. The Board awards briefly are as follows:—

*Sunday Duty.*—The present practice is maintained, namely, all time worked between midnight Saturday and midnight Sunday is paid at the rate of time-and-a-half, except that double time is paid to platelayers and others employed on Sundays for special work on the permanent way. At present a turn of duty commencing on Sunday and extending beyond midnight into Monday is paid as for a Sunday turn; the companies claimed that time-and-a-half should be paid only from midnight Saturday to midnight Sunday, and the Board upheld this claim. The award also establishes the minimum pay for Sunday duty by various grades of workers.

*Night Duty.*—The award finds the present position to be a compromise which should be maintained in regard to the conciliation grades (time-and-a-quarter for all ordinary time between 10 p.m. and 4 a.m.). In regard to clerks, the duration of the night work comes in and the Board understands that the parties are to discuss the point further.

*Classification of Enginemen.*—The present system of mileage duty to be retained, but the basis to be 150 miles per day; mileage in excess to be paid on the basis of 15 miles an hour. There is some cause for discrimination in the case of drivers on shunting engines, shed-yard engines and on engine preparation, and for such men the daily pay to be: First and second years, 12*s.*; third and fourth years, 13*s.*; fourth year and onward, 14*s.* Other drivers, firemen, motormen and assistant motormen to remain on the present scales.

*Disposal of Engines.*—Allowances are now made to men for disposal of engines; the companies proposed that the 15 minutes allowance for booking off, &c., should include certain specified duties in the absence of which no allowance should be made, and, where certain of the duties were omitted, the time allowance should be reduced. The Board held that the companies' proposal should be conceded.

*War Bonuses and Cost of Living.*—The Board concludes that the time is not ripe to interfere with the operation of the sliding scale. It adds that the existing agreements under which the conciliation locomotive grades after twelve months service are entitled to one week's holiday with pay should remain undisturbed.

*Extended Roster.*—Under the Board's decision in the case of the Scottish companies, subsequently extended to the English companies, permission was given, in instances where economy would accrue, to extend the roster to nine hours per day. The Board is not satisfied that this should be rescinded.

*Allowances for Junior Clerks.*—In the matter of the claims for an extra allowance to junior clerks under 17 who live away from home, the Board feels that this is not one in regard to which the companies should be placed under a definite obligation, but understands that the companies are willing to consider the cases where present arrangements may result in hardship.

The changes dealt with in the report are to have effect as from the beginning of the third full pay week of January.

---

The railway companies are reported to be disappointed at several of the Board's findings, but that they will abide by them is certain. The National Union of Railwaymen have decided to accept them, as was to be expected from statements made by Mr. J. H. Thomas and Mr. C. T. Cramp, secretaries of that union. On the other hand, the Associated Society of Locomotive Engineers and Firemen have decided that "before the findings are put into operation by the companies, a ballot is to be taken of all members concerned, and should the members reject the findings, the executive committee is to call a general strike." Should a strike occur it would be likely to involve the engineers and firemen only, and not the National Union of Railwaymen who, we believe, count in their ranks, many thousand engine drivers, motormen and firemen.

---

The Committee of the Federation of British Industries which was appointed in February last to consider the question of taxation has now issued its report. It says that of the huge amount levied annually for the national exchequer, by far the largest portion is derived in one form or another from industrial sources. There is also the further contribution made by industry in the form of rates. A fact which intensifies the burden is the unfair inclusion of machinery for rating purposes, this accentuating the inequalities as between industrialists and other ratepayers. In reviewing items of expenditure the committee does not wish to suggest that the objects of this expenditure are not from a social point of view eminently desirable. The committee believes, however, that largely owing to the unsatisfactory demarcation of functions between the central and local authorities, administration has not been upon the best commercial basis, and that the results obtained have hardly been commensurate with the expenditure involved. The committee regrets to record the general apathy shown by industrialists in not serving on local authorities and in not encouraging their staffs to do so.

---

In the course of the year 1922, according to statistics now issued, 13 Belgian works manufactured pig-iron, as against 19 in the year 1913. The furnaces in blast numbered 41, as against 54 in 1913. The number of men employed at the blast furnaces numbered 4,419 in 1922, or very little below the figure for 1913. The pig-iron production per man employed in 1913 and 1922 was respectively 470 tons and 361 tons. In 1922 the coke consumption at the Belgian blast furnaces was 1,627,730 tons, of which 376,030 tons, or 23·1 per cent., were imported. The quantity of Belgian coke utilised for pig-iron making is 43·9 per cent. of the total Belgian coke production. The coke consumption per metric ton of pig-iron was 1,009 kg.; the corresponding figure was 967 kg. in 1921, 1,088 kg. in 1920 and 1,072 kg. in 1913. The consumption of iron ore in 1922 was 3,638,450 tons, of which only 61,638 tons (1·7 per cent.) were of Belgian extraction; France supplied 2,460,350 tons; Luxemburg 750,850 tons; Sweden and Norway, 300,750 tons; Spain, 63,250 tons. Belgium, in 1922, produced 1,613,160 tons of pig-iron, as against 2,485,000 tons in 1913.

---

Great Britain's recent decision to continue its traditional policy of free trade, as expressed by the result of the general election, is of more than momentary importance to American manufacturers of mechanical devices and equipment, according to *The Iron Trade Review*, Cleveland, O. The American iron and steel industry was not specially concerned, for the export of its products to British consumers amounts only to about 5,000,000 dols. a year. But it was otherwise for the makers of machine tools, foundry appliances, miscellaneous shop machinery and engineering equipment, small tools, textile machinery, sewing machine parts, typewriters, electrical machinery and a long list of similar products. The export trade with Britain in these is about 25,000,000 dols. annually. A yearly business of at least 30,000,000 dols. in these two branches of industry alone was imperilled by the programme of the British Conservative Party. Our American contemporary adds that motor cars and accessories are already subject to a duty of 33⅓ per cent. and this has proved a serious handicap, so that it has had a tendency to direct American capital into British manufacturing channels. Such statements as the above deserve the careful consideration of all British citizens.

---

American Imports of Iron Ores.—We read in *The Iron Age*, New York, that iron ore has been coming into the United States in greater volume this year than at any time in the last decade under peace-time conditions. To October 1, over 255,200 gross tons per month had been imported, or more than three times as much as in the first nine months of 1922. The largest previous average was 216,230 tons per month in 1913. Freight rates are so high on ore from Lake Superior to Eastern furnaces that the latter have had to turn to foreign ore. Imports from Sweden are the largest factor in this year's movement whereas ordinarily Cuban ores have led. To October 1, the total from Sweden was 674,000 tons and from Cuba 602,000 tons.

---

The Specific Heat of Coal.—The specific heat of coal has been studied less than one would expect from the importance of the subject. If the value 0·35 be taken instead of 0·25 for this specific heat, it would indeed matter little as regards the thermal balance sheet in the manufacture of coke and gas; but it would make a great difference as to the spontaneous heating of coal. The determination of the specific heat is difficult because coal is a poor conductor of heat; a heated bulk of dry powdered coal will not have the same temperature throughout, there is risk of oxidation, and when the coal is wetted with water or toluene for calorimetric tests, heat is generated. For this and other considerations, G. Coles, of Birmingham University (Journal Society Chemical Industry, November 16) adopted the Bunsen ice calorimeter as likely to give the most reliable results. Testing first Hamstead Brazill coal he found that with the moisture content of the coal decreasing from 15 per cent. down to 1·5 per cent., the specific heat diminished from 0·355 down to 0·252, the regular decrease indicating that the water acted as if free and not as if bound in chemical combination. These figures were confirmed by experiments with various coals, coals of the same class and of similar percentage composition giving, when reduced to the dry, ash-free basis, specific heats of the same order, viz., fusains 0·21 or 0·22, anthracites 0·22 or 0·23, bituminous coals 0·24 to 0·26. As regards composition and Kopp's law (according to which the molecular heat of a compound is the sum of the atomic heats of the constituents), Coles observed that the specific heat could be calculated from Kopp's law when the carbon: hydrogen ratio was high and the content of volatile matter low, but not for bituminous coals; on the other hand brown coal, though containing much hydrogen, oxygen and volatile matter, also conformed to the law. In general, the specific heat may be assumed to be 0·25 or less for dry coal rising to 0·4 with increasing moisture.

## YEAR BOOKS AND ANNUALS.

*Second Year Book of the Institution of Rubber Industry*, 1923.—The Second Year Book of the Institution of Rubber Industry (published at the Offices, 10, Charing Cross-road; price 5*s*.), an octavo volume of 448 pages, records a gratifying development of the Institution which is "to promote a better understanding and a closer relationship between all sides of the rubber industry." By the end of August, 1923, the number of members had risen to 490, from 257 in 1922. Four classes of membership are distinguished, full members, merchants, associates and graduates; the graduates, employees of members, small retailers and students, are not entitled to vote. Altogether 23 meetings were held in London (11), Manchester (10), and Birmingham (2); the year book reprints the papers and discussions partly in abstract. In merit the papers vary as much, as the branches of the rubber industry and their products. Mr. B. D. Porritt on "The Scope and Progress of the Research Association of the Rubber and Tyre Manufacturers," at Croydon; Dr. J. Torrey on "Reclaimed Rubber"; Mr. J. H. Wild on "Solvent Recovery Processes"; Dr. D. F. Twiss on "The Value of Rubber Pigments"; Mr. H. Savage on "Telegraph Cable Manufacture"; and Mr. W. S. Flight on "The Use of Rubber Products as Dielectrics," had contributed much to the point. To characterise Mr. D. F. L. Zorn's address on "Symbolic Rubber" we need only quote one of his "statements of literary facts: A granite mountain or a flash of lightning are simply different manifestations of one and the same thing—pure energy." We have noticed some of the other papers; most of the reports are not illustrated. The question of secrecy often came up during the discussions, sometimes in peculiar ways. One rubber manufacturer, it was mentioned, complained that a machine had suddenly broken, but refused to answer the questions of the engineering firm who had supplied it as to the conditions of the failure.

*The Mechanical World Year Book*.—The new issue of this popular annual is the 37th of the series. Each fresh edition has embodied additions to the text, or revision of matter which required bringing up to date. One new feature on this occasion is a section on the combustion of fuel, and another addition is a comprehensive but concisely arranged series of rules for the strength of flat plates, which will undoubtedly prove very useful, although in practice, such plates if subject to a unidirectional load only, prove very much stronger than is indicated by the usual theory. The tabular matter includes tables of squares, cubes, square roots and cube roots of all integers up to 1,000. The four-figure logarithmic tables are printed on opposite pages, so that each figure required is found without requiring the turning of a page. We would suggest that the central column of figures might be enclosed between heavier rules, both here and in the table of ante-logarithms, so as to guide the eye more effectively to the number required. The volume is strongly bound and is published by Messrs. Emmott and Co., Ltd., Manchester, at 1*s*. 6*d*. net.

*Highway Engineers' Year Book*, 1924.—Edited by Mr. H. Gilbert Whyatt, M.Inst.C.E. London: Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, W.C.2. [Price 6*s*. net.] This is the first appearance of this year book, which should be one of considerable possibilities. While a good start has been made, all sections of the work are not equally satisfactory, and some are capable of considerable improvement. The fact that the book is published so soon after the recent exhibition at the Agricultural Hall brings into important prominence the fact that a very large number of new and interesting designs of plant are not included in this work. For instance, as our pages have shown many new types of rollers, concrete mixers, tar macadam and other plant, were conspicuous at this exhibition, but possibly were too recently produced to be included in a work which, of course, must have taken some time to compile. The editor has clearly been placed in a difficult position. We are not satisfied that the editor's system of allowing makers to state their claims in their own words is good, for it leads to absurdities, one maker claiming among the advantages of motor road rollers over steam rollers, the fact that "wheels are all steel"—a feature not necessarily exclusive to motor-driven machines. Another claim is "radiators of solid construction"—this, of course, by the nature of things is not a comparison. With less compilation and more editing, we hope this volume may become an authoritative record of progress.

*Calverts Mechanics' Almanack*.—The new issue of this almanack has just been published by Messrs. John Heywood, Ltd., Manchester; price 6*d*. It is now edited by Messrs. F. Nasmith and F. Poulton. The contents consist largely of workshop hints, many of them showing considerable ingenuity, and there is also a large selection of trade recipes. The matter is specially well adapted to the needs of those whose knowledge of mathematics is somewhat rudimentary. Very few formulæ are used, and those that are employed are of the simplest type. A wages table, which is included in the test will undoubtedly prove a convenience to many.

## "STRESSES IN BRIDGES."

To the Editor of Engineering.

SIR,—The report on stresses in bridges written by Professor Haigh and myself for the Complex Stress Committee of the British Association which was reprinted in your issues of September 28 and October 5 contained three misprints not noticed when the proofs were passed, and I would like the corrections to be on record in your pages.

In the top line of Fig. 1, page 413, the = sign refers to the square dots plotted in the diagram.

The figure 2,852 million, page 446, second paragraph, middle column, should be 2·852 million.

In the drawing of Fairbairn's test girder, Fig. 6, page 447, the webb thickness should be ½ in. and not ⅝ in., as shown.

Yours faithfully,
J. S. WILSON.

Bridge House, 181, Queen Victoria-street,
December 21, 1923.

## "POWDERED COAL FOR STEAM RAISING."

To the Editor of Engineering.

SIR,—With reference to the article in your issue of December 14 (page 747) entitled "Powdered Coal for Steam Raising" there are two points which I would like to amplify. The first is the floor space taken up by a boiler fired by powdered coal and including unit pulverisers. Actually, in the vast majority of cases, the floor space can be reduced without adding to the necessary height of the boiler house. This is particularly the case when boilers with nearly vertical tubes are made use of. In the last paragraph of the article you state you believe that central plants at present hold the field in number and in importance of plants equipped, while this is correct, we believe, in the United States it is interesting to obtain a comparative figure to that given by Mr. David Brownlie, whose paper is referred to. He gives a figure of 850,000 tons to 1,000,000 tons per annum used by one system of central pulverisation, which system we are led to believe is the most important in the United States. It is difficult to know how this figure is arrived at, and we can only assume that he took the normal output of the plants over a normal number of working days per annum. If we take one system of unit pulverizers, the turbo-pulveriser, and calculate the normal output of those ordered, we get an annual output of over 1,800,000 tons estimating on a working year of 300 days.

I am, Sir, yours faithfully,
P. E. ATKINSON.

The Powdered Fuel Plant Company, Limited, 47,
Victoria-street, Westminster, London, S.W.1,
December 20, 1923.

To the Editor of Engineering.

SIR,—With regard to the editorial in your issue of the 14th inst., and Mr. Bell's letter of the 21st inst., I should like to point out that your editorial is rather apt to give a wrong impression of the true facts of pulverised coal as applied to steam generation. You say "experience appears to prove that this complexity of plant (on the central system) is unnecessary and that equally satisfactory results can be obtained by pulverising the undried coal at the boiler front as it is required, and feeding it directly from the pulveriser to the burners." I suggest that experience proves exactly the reverse.

The simple facts are that in the United States the so-called "unit" pulveriser has made little or no progress for steam generation, and no figures at all are available for continuous running as applied to a moderate-sized or large boiler plants. Various firms in America have spent huge sums of money on investigating the problem in the most elaborate manner and the general opinion is, that the "unit" pulveriser is not satisfactory. This was the very reason the so-called "central" system was invented at all, the necessity of having, for efficient results, entirely separate drying, pulverising, separating and feeding. You say, evidently with approval, of the unit pulveriser, "the machine employed is a fuel regulator, a pulveriser, and a furnace feeder all in one." This explains one of the very many reasons of its lack of success, the fact that it is impossible to carry out at high efficiency three different operations at the same speed in one and the same machine.

As a consequence steam generation by pulverised coal, on systems the reverse of the unit principle, is advancing by leaps and bounds, and since the Lakeside plant on the "Lopulco" system was started up in December, 1920, 360,000 sq. ft. of heating surface is in operation and 1,400,000 sq. ft. is being equipped, whilst the application according to the unit system is negligible. Experience does not prove that all this complexity of plant is unnecessary. On the contrary, two of the most remarkable and efficient boiler plants in the world, Lakeside and the River Rouge, are running on this principle. The latest "Lopulco" designs have certainly done away with the central pulveriser building, and the large rotary drier, but the principle remains the same, that is, a number of independent operations carried out separately at maximum efficiency, as opposed to one machine trying to combine entirely different functions. The plant is not complicated nor does it occupy a lot of room. Each boiler has its own small vertical drier, pulveriser, separator, pulverised coal bunker, feeder and burners, and the wear and tear, liability to breakdown, maintenance costs, efficiency, flexibility and many other points are superior to three or four mechanical stokers and ash conveyors.

As compared with a unit pulveriser there is hardly any comparison from the point of view of efficiency, auxiliary power used, regular and even grinding, control from a distant switchboard, ability to operate the largest boilers and many other factors, whilst the space occupied is very little more. Also as already described in my paper "Pulverised Fuel and Efficient Steam Generation," the figures for pulverised coal application on the "Lopulco" system alone will soon be equivalent to the burning of 3,500,000 tons of coal per annum, equal to half the output of all the power stations in Great Britain put together, and they include some of the largest and most efficient stations in the world, such as the Ford Plant, River Rouge, Cahokia (St. Louis), Cleveland, Detroit Edison (Trenton Channel), Colfax, and Vitry (Paris). No unit system has, of course, anything like this to show, whatever may happen in the future.

Yours faithfully,
DAVID BROWNLIE.

46, Grange-road, Ealing, London, W. 5,
December 24, 1923.

## THE OPTICAL SOCIETY.

A MEETING of the Optical Society was held at the Imperial College of Science and Technology, South Kensington, on Thursday, December 13. A paper on "*The Primary and Secondary Constant Magnification Surfaces of Thin Lenses*," was read by Mr. T. Smith, M.A., F.Inst.P. The author showed by theoretical consideration that the surfaces of constant magnification on which the primary and secondary focal lines for a thin lens are situated form families of similar surfaces, and lie between easily constructed surfaces (spheres for the secondary surfaces) determined by the power of the lens together with the Petzval sum for the one limit and the sum of the lens curvatures for the other.

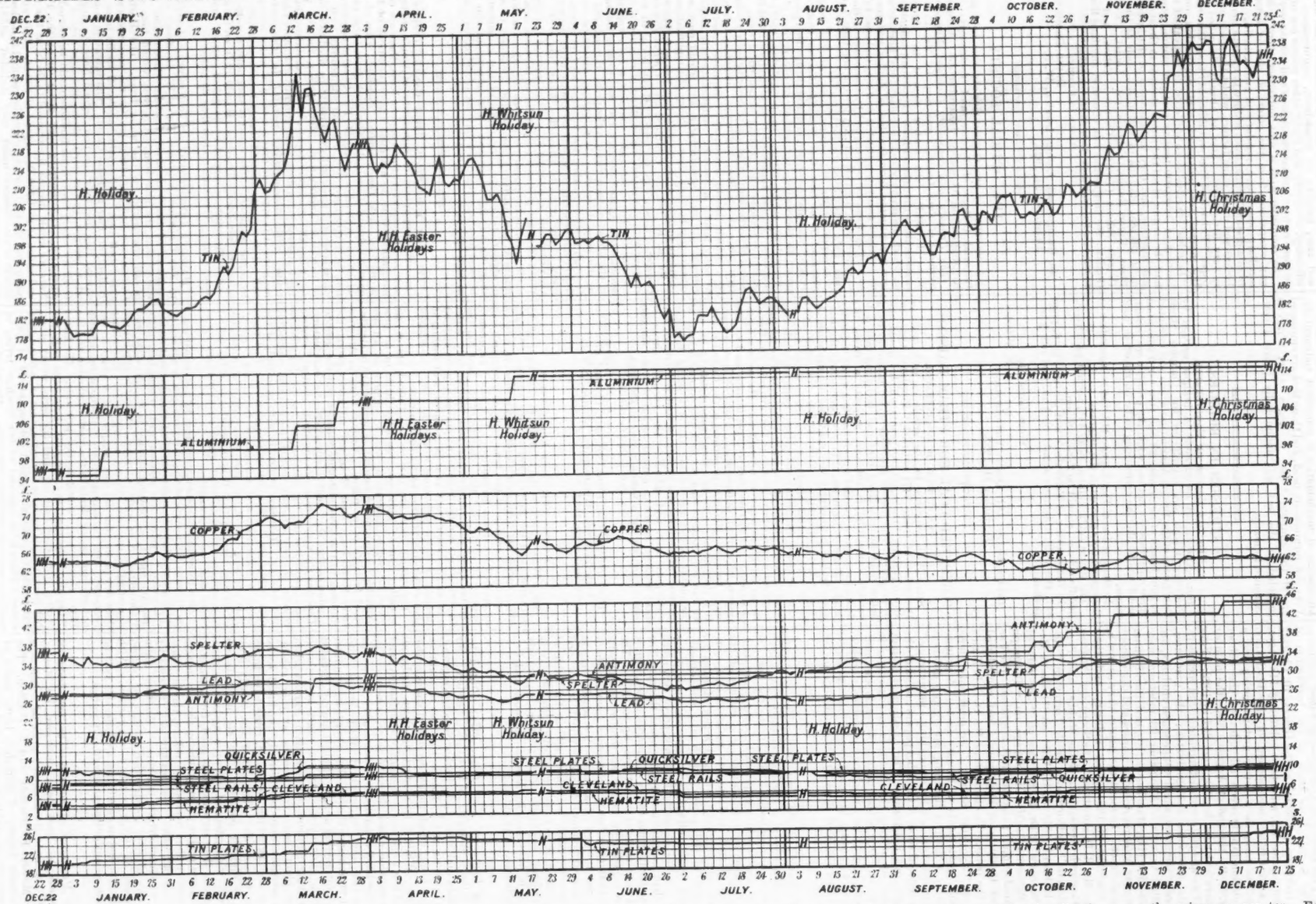
A paper by Mr. W. Swaine, B.Sc., on "*A Suggested Standard Trial Case and Simplification in Ophthalmic Policy*," was also presented and discussed. In a previous paper to the society the author gave a review of the cumulative errors arising in present-day ophthalmic practice. It was suggested that plano-form trial lenses should supersede the existing symmetrical form. The object of the present paper was to describe such a standard trial case with specified thicknesses, diameters, tolerances, &c., which would introduce minimum confusion—actually none—in practice, would materially help both refractionist and manufacturer, and would remove the uncertainty between them. Policy of simplification and economy in ophthalmic manufacture was also suggested.

Mr. B. K. Johnson exhibited an "*Optical Revolution Counter*" which can be used without being in actual contact with the object whose speed of rotation is being measured. The instrument contains a reversing prism which when rotated through 180 deg. rotates the image of the object as seen through the prism through 360 deg. in the same direction. If a rotating object be viewed through the prism when the latter is also revolving, the object can be made to appear stationary when the correct speed of the prism is attained. When this is the case the prism will be rotating at half the speed of the object. When two such prisms are mounted on the same axis and made to rotate in opposite directions the prisms need only rotate at one-quarter of the speed of the object to make it appear stationary. The range of the instrument is thus considerably increased. The instrument can also be used for observing the behaviour of objects revolving at high speeds.

THE NEW YORK STATE BARGE CANAL.—Despite the common assumption of superiority of water transport over rail transport on the economic basis, there are canal navigations that do not meet the expectations of their promoters, says *The Canadian Engineer*. One of the most notable of these is the New York State barge canal, which was evolved out of the old Erie Canal at an expenditure of 170,000,000 dols. As an engineering work the canal is most praiseworthy and might be cited as a model of excellent construction. Nevertheless, for the past ten years the officials charged with the administration of the waterway have done their utmost to promote paying traffic, with disappointing results. In this notable instance, it is apparent that a system of water transport will not necessarily succeed simply because it is different from rail transport. The canal is essentially a restricted artery of transport. The depth is only 12 ft. on the sills, and traffic must be carried by barges of certain limited dimensions. There are no less than 35 locks.

HARBOUR IMPROVEMENT AT VANCOUVER.—According to *The Canadian Engineer*, Major W. G. Swan, chief engineer of the Vancouver Harbour Commission, has stated that the new terminal railway would take care of all the traffic on the water front. The Harbour Commission had the machinery for the construction of this "belt line" and would handle all traffic from the Ballantyne Pier to False Creek. The intention was to extend this line over the new Second Narrows Bridge, when erected, to the north shore, and thus extend the territory where waterfront business could be carried on efficiently. The dredging now going on at the First Narrows would deepen the channel to 36 ft. at low tide and widen it to 1,200 ft. instead of 900 ft. This would mean that the tide current would be reduced to 4½ knots. Minor improvements under way included additional elevator accommodation, and the building of a grain jetty to increase the delivery capacity of the elevators.

# DIAGRAMS SHOWING FLUCTUATIONS IN THE PRICES OF METALS FROM CHRISTMAS, 1922, TO CHRISTMAS, 1923.

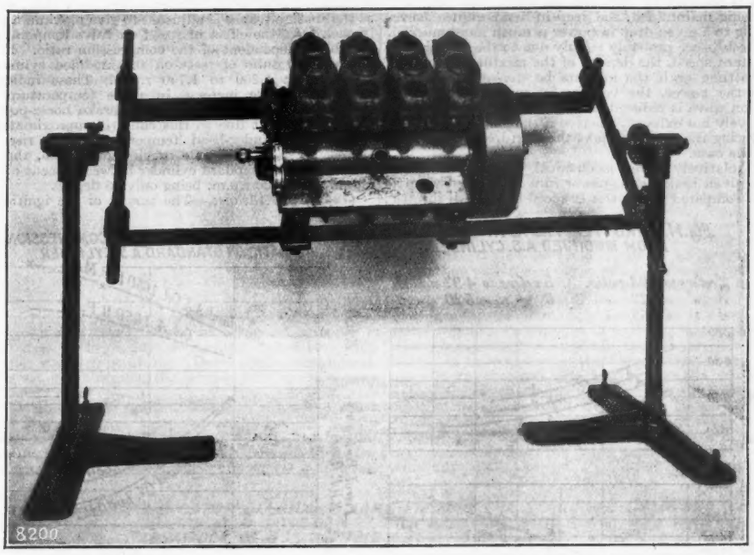



(8202)

NOTE.—The figures for tin and copper are the official closing cash quotations of the London Metal Exchange for fine "foreign" and "standard" metal respectively. The prices for lead are for English metal; those for spelter for American metal. Middlesbrough prices are plotted for steel plates and rails, and also for hematite and Cleveland pig-iron. The prices given in the case of steel plates are for ship, bridge and tank qualities, and those for steel rails are for heavy sections. The pig-iron prices are for East Coast hematite and Cleveland iron, both of No. 1 quality and for home consumption. The price of tin plates is per box of I.C. cokes f.o.b. at Welsh ports, but in all other cases the prices are per ton. Each vertical line in the diagram represent two market days, and the horizontal lines represent 2*l.* each, except in the case of tin plates, where they represent 2*s.* each.

# UNIVERSAL MOTOR-ENGINE STAND.

CONSTRUCTED BY MESSRS. F. H. EVE, LIMITED, ENGINEERS, LUTON.



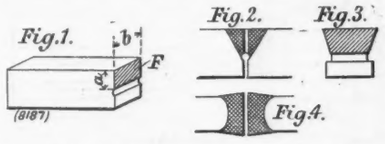

IN many classes of work in the assembly and repair of motor car engines it is desirable to be able to tilt the engine to a greater or less extent and keep it in that position until the particular work on it is completed. The accompanying illustration shows a workshop stand designed and constructed for this purpose by Messrs. F. H. Eve, Limited, of Old Bedford-road, Luton. This consists of a frame on which the engine may be mounted and which is supported on two uprights with large tee-shaped cast-iron bases. Provision is made for locking the device in any desired position.

The side arms of the frame may be connected at any points on the end bars, and may thus be either parallel or inclined to each other to accommodate the engine, the gear-box or whatever else the stand is used for. Brackets are interposed between the plant and the side arms of the stand, and these may be fixed wherever required. They are shaped so that the actual connection of the engine may be above or below the side arms, whichever provides the nearer approach to perfect balance and thus makes the smallest effort necessary in turning the loaded frame. On the top of the uprights the supporting bearings are situated and they have flanges at the inner ends. Pins can be passed through the holes drilled in these, and into similar ones in the flanges on the shafts of the frame, and thus the engine may be maintained in any position as long as is desired. The stand has proved useful in many services, such as grinding in valves, drilling out broken studs, bedding in crankshaft bearings, fitting pistons and connecting rods, assembling cylinders, water pipes, inlet and exhaust manifolds. Engines may be run in on the stand from line shafting, by means of a belt, using the flywheel as a pulley. For this purpose the stand has many advantages as it is possible to watch the big-end and the crankshaft bearings, while the operation is in progress. As there are no explosion noises to drown those caused by defects, such as loose pistons, tight gudgeon pins, loose rings, &c., the suitability of this method of running in is apparent. The stand is made in two sizes, the one suitable for all engines used on motor vehicles of sizes up to 5-tonners and the other for heavy service. Both models can be supplied fitted with wheels, two of which run on castors, to facilitate transport, and have lifting screws at each corner to raise the stand off the wheel support to obtain rigidity when working. The tying of the two bases by a strap is used to strengthen the structure, although that is not shown in the illustration.

PETROLEUM IN UGANDA.—According to *The South African Mining and Engineering Journal*, news comes from Fort Portal of a discovery claimed to be of great importance to Uganda, and perhaps to Kenya, to the effect that petroleum has been found near Kibero, on the Lake Albert Flats, by the Government geologists. Three barrels of this petroleum have been sent to England for analysis. Meanwhile the Government are sending out boring outfits, and the Assistant Geologist is camped at the well. It would appear that this may be a continuation of the Inyaminga petroleum measures.

## THE SIGNIFICANCE OF THE NOTCHED-BAR IMPACT TEST.

WHEN the Institution of Civil Engineers discussed notched-bar impact tests and their standardisation three years ago in connection with papers by Dr. Stanton, Sir Robert Hadfield and others*, a very striking example of the difficulties of co-ordinating the results of tensile tests and shock tests was quoted by Sir Robert. A good mild steel had, after quenching and tempering, given an elongation of 35 per cent. and a reduction in area of 65 per cent; the same steel, cooled slowly from 1,200 deg. C., showed an elongation and a reduction of 46 per cent. and 64 per cent. respectively. Yet under the dynamic shock test the steel proved exceedingly brittle, snapping almost like cast iron; the tensile test had given no indication of this inferiority. From these and other considerations a complete standardisation of impact tests appeared inadvisable at the time. It was particularly recognised that the velocity of impact had an important, but insufficiently investigated bearing upon the test results. Since then a good deal of further work at high striking velocities has been done, notably at the National Physical Laboratory, and we see from recent publications in *Stahl und Eisen* of July 19 and November 15, that the cognate researches of Dr. Ing. M. Moser have led to conclusions substantially in agreement with those drawn by the workers mentioned, whom he




quotes. Moser's views on the significance of the notched-bar impact test, and the comments on these views by Professor A. Ludwik, of Vienna, another authority in this field, are interesting.

In order to deduce comparative values of impact strength from notched-bar impact test data the observed work done in fracture is usually referred to the cross-section fractured. But F. Schüle pointed out at the International Material Testing Congress, held at Copenhagen in 1909, that the work done should be referred to the mass of metal actually absorbing the energy of the blow, and that it was possible to estimate this volume from the region of plastic flow. Adopting this suggestion, Dr. Moser, of the Krupp research staff in Essen, found the deep-etching method of Fry (ENGINEERING, December 16, 1921, page 809) very useful for this determination. The German standard specimen for such tests is illustrated in Fig. 1; the shaded area $F = ab$, where $a = 1{\cdot}5$ cm. and $b = 3$ cm., is the product by which the work done in fracture is divided in deducing the impact strength. Schüle substitutes for this F the volume V of plastic flow which Moser finds takes the shape illustrated in Figs. 2, 3, 4. Testing various carbon and alloy steels and varying the width $b$ of the specimen and the striking velocity, Moser concludes that the work done in fracture represents the product of two factors, viz., the amount of work W absorbed by the unit volume of the specimen and the number of volume units N participating in this absorption. The product W N is determined by the test; the separate factors are unknown but they can be estimated by varying the experimental conditions.

According to Moser the factor W has, for a certain material, a value which is independent of the shape of the specimen and the striking velocity, and is influenced only by the thermal treatment or constitutional changes; the W is his "work constant." The factor N, on the other hand, changes both with the shape of the specimen and the striking velocity, but there is for each test of a specimen of a certain standard a maximum value of N, independent of the material. This maximum naturally increases proportionally to the width $b$ of the specimen. How closely that maximum will be attained in any particular case, however, depends upon the striking velocity. Experimenting with a tough chrome-nickel steel and a carbon steel of medium tenacity, Moser observed that the maximum N was always reached in the former case, but only at moderate striking velocities in the case of the carbon steel. At high striking velocity the N fell much below its maximum value, as soon as the width $b$ exceeded 2 cm.; wide specimens proved, indeed, relatively very weak. All materials would probably fail to attain the N maximum at very high striking velocities. But why the great differences? Because, Moser argues, the alloy steel was able rapidly to adapt itself to deformation and sudden strains, owing to its high rate of "work velocity," while the carbon steel, too sluggish to take up high strains, broke. High "work velocity" is required, for instance, for a car-wheel axle exposed to sharp blows. This work velocity can be determined by shock tests at low and high velocities, such as Hadfield and Main proposed, and also, Moser shows, without special machinery, on customary impact machines with the aid of specimens of different widths.

According to Ludwik, the "work constant" of Moser would approximately correspond to the reduction of cross-section of the tensile test, and his "work velocity" to a new property which does not reveal itself before a certain critical velocity of blow is exceeded; the latter, will, other circumstances being equal, be lower, as the specimen is wider and the notch sharper. The more elongation and reduction of area of cross section are impeded, the smaller will be the striking velocity which would make a material appear brittle. Given sufficient stiffening and velocity all materials will be brittle. Why the same material should appear tough or brittle according to the rate of deformation capacity (work velocity) Ludwik would explain as follows:—In solids, as in liquids, internal friction and resistance to shear depend upon the rate of flow. In liquids these two quantities (at constant temperature) are proportional to one another; in metals the curve is logarithmic, as his experiments on the rate of stretching tin wire had proved. As the rate of deformation is increased, the resistance to deformation increases. When the cohesion (which must not be confounded with the tensile strength) is great by comparison to the shear strength, the material will appear tough. When at higher rates of deformation the shear resistances predominate, the cohesion fails locally and fracture ensues. Moser's work velocity would thus depend upon the magnitude of cohesion and upon the increase of internal friction with the rate of flow. This increase is very noticeable in the case of zinc; a zinc rod may be folded by slow bending, but it breaks under shock and exhibits after-flow in hardness tests.

* See ENGINEERING, December 3 and 17, pages 735 and 806, of vol. cx. Proc. Inst.C.E., vol. cexi, page 67, *et seq.*

ELECTROLYTIC IRON FROM PYRITE.—We read in *The Iron Age*, New York, that Mr. W. B. Timm, chief of the division of ore dressing and metallurgy of the Dominion Department of Mines, has announced that the Canadian Government is building a laboratory at Ottawa for the purpose of continuing the experimental work, initiated at the laboratory at the Trail Smelter, of manufacturing iron electrolytically from the pyrite and pyrrhotite tailing of Canadian copper, nickel and lead-zinc ores. Some fifteen months ago, Mr. S. G. Blaylock, managing director of the Consolidated Mining and Smelting Company, announced that an exceedingly pure iron had been made in the laboratory at the Trail Smelter from the tailing of the company's Sullivan mine ore, and that an electrolytic process had been used in the manufacture of the iron. At the present time, the mill at the Sullivan mine, at Kimberley, B.C., is producing daily more than 1,000 tons of tailing, which is composed mainly of pyrrhotite and will average in the vicinity of 40 per cent. of iron. Should it be found desirable, the iron content could be raised slightly without great additional cost.

CANADIAN IRON AND STEEL PRODUCTION.—We read in *Iron and Steel of Canada* that the production of pig iron and ferro alloys during September was 75,216 long tons, a decline of 18·8 per cent. from the August production of 92,587 tons. The output of basic pig iron was 27·5 per cent. less at 46,580 tons; foundry iron amounted to 17,536 tons, a decline of 29·8 per cent.; the output of malleable iron showed an increase of 232 per cent., the total being 11,100 tons. The production for the three quarters ending September was 684,596 tons, the output for the nine months of 1922 and 1921 being 275,989 tons and 457,157 tons respectively. Two furnaces at Sault Ste Marie were banked leaving seven furnaces in blast at the end of the month, including two at Hamilton, Ont., one at Port Colborne, Ont., one at Sault Ste Marie, Ont., and three at Sydney, N.S. The steel production in September was 66,334 gross tons, as compared with 105,056 tons the preceding month. The production for the nine months ending September was 721,352 tons, the production for the same periods of 1922 and 1921 having been 334,835 tons and 477,588 tons respectively.

No. 1 quality and for home consumption. The price of tin plates is per box of I.C. cokes f.o.b. at Welsh ports, for ship, bridge and tank qualities, and those for steel for lead are for English metal; those for spelter pig-iron. The prices given in the case of steel plates are and the horizontal lines represent 2/. each, except in the case of tin plates, where they represent 2s. each.

## EXHAUST-VALVE AND CYLINDER-HEAD TEMPERATURES IN HIGH-SPEED PETROL ENGINES.*

By Professor A. H. Gibson, D.Sc., Member, and H. Wright Baker, M.Sc., of the University of Manchester.

(*Concluded from page* 788.)

(9) *Effect of the Output of the Engine under Variable Throttle.*—Since the mechanical friction in the single-cylinder test-bed is relatively greater than the friction per cylinder in a six-cylinder engine, a series of tests were made on the single-cylinder unit to determine the mechanical and pumping losses with the engine hot, by driving it from an electric motor. As a result of these tests the brake correction was obtained which would make the mechanical efficiency 90 per cent. at full throttle; probably a reasonably close approximation to the mechanical efficiency of the multi-cylinder unit, and this correction has been applied in deducing the values of the brake horse-power given in the paper.

Fig. 13. THROTTLE TESTS—STANDARD A.S. CYLINDER (e).

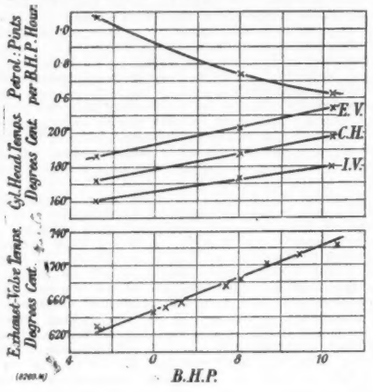



Fig. 14. THROTTLE TESTS AT 1,680 R.P.M. FROM MODIFIED A.S. CYLINDER.

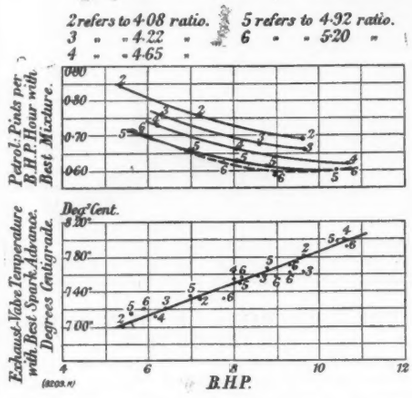

2 refers to 4·08 ratio. 5 refers to 4·92 ratio.
3 " 4·22 " 6 " 5·20 "
4 " 4·65 "
Petrol: Pints per B.H.P. Hour with Best Mixture.
Exhaust-Valve Temperature with Best Spark Advance. Degrees Centigrade.
B.H.P.

Fig. 15. EFFECT OF A VARIATION IN COMPRESSION RATIO ON STANDARD A.S. CYLINDER.

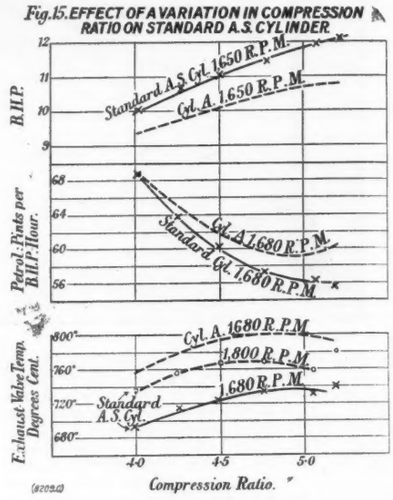



Fig. 16. SPEED TESTS. STANDARD A.S. CYLINDER.

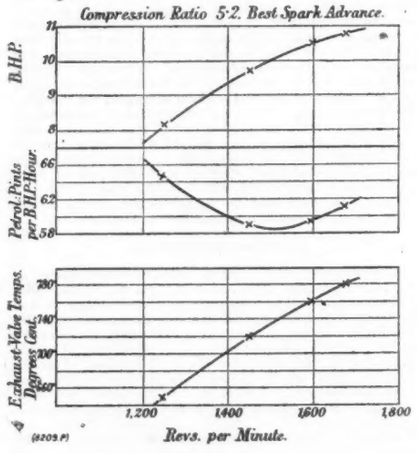



Fig. 17. SPARK ADVANCE TESTS. STANDARD A.S. CYLINDER.

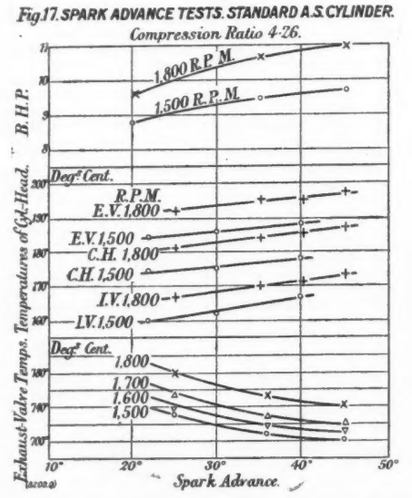
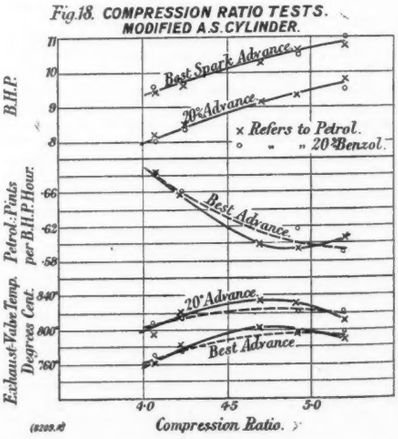



Fig. 18. COMPRESSION RATIO TESTS. MODIFIED A.S. CYLINDER.




The power tests were run at constant speed and with variable throttle openings, the carburettor being adjusted to give approximately the weakest mixture capable of developing the maximum power corresponding to this opening. A typical set of results is shown by the curves of Fig. 13. These have been modified slightly so as to correspond to a constant A/P ratio of 14·5, the average ratio obtained during the tests.

From one-half to full power the valve temperature increases almost uniformly with the output at the rate of about 20 deg. per brake horse-power. The curves of cylinder-head temperature again follow very closely those of exhaust-valve temperatures, the variation per brake horse-power being about 4 deg. C. for group E.V. and 3 deg. C. for group I.V. These results are confirmed by tests on the modified cylinder as shown in Fig. 14. From these it appears that if the compression ratio is varied, the valve temperature attained with any given brake horse-power, below the maximum obtainable with the lowest compression ratio, is independent of the compression ratio.

It is of interest at this point to return to the curves of Fig. 10 (page 787 *ante*). These show a rapid diminution in valve temperature as the power is reduced by weakening the mixture beyond about 15 : 1, A/P ratio. On the average the drop in valve temperature at a given speed amounts to 17·5 deg. C. for each horse-power by which the output is reduced, or very nearly the same as in the throttling tests. It thus appears that a reduction in horse-power below the maximum of which the cylinder is capable, whether produced by throttling or by weakening the mixture, produces sensibly the same reduction in valve temperature.

As shown by the experiments, this is true over the whole range of compression ratios and speeds examined. On the other hand, as indicated by Figs. 10 and 16, if the output is reduced by reducing the speed, the best A/P ratio being maintained, the drop in temperature corresponding to a given drop in power is much more marked. These results are probably mainly due to the fact that if, at constant speed, the density of the mixture be reduced by throttling or if the mixture be weakened so as to reduce the power, the velocity of propagation of the explosion wave is reduced, thus giving slow burning and a relatively hot exhaust, whereas if the power be reduced by reducing the speed, keeping the mixture constant, this is not the case.

The relatively lower mechanical efficiency obtained with a given brake horse-power in a high-speed throttle test, as compared with a slower speed but at full throttle, is a further factor tending to modify the results in the direction indicated by the experiments.

(10) *Compression Ratio.*—The compression ratios used, ranging from 4·0 to 5·2, sufficiently cover both extremes for the cylinder under test, the power available at the lower compression being below that reasonably attainable, while at the highest ratio detonation is well marked and regular. No detonation was detected at the ratio of 5·07, except at comparatively low speeds.

The curves of Fig. 15 show the maximum temperatures attained at full throttle with the weakest mixture capable of giving maximum power, and at 1,650 r.p.m. and 1,800 r.p.m. respectively. If these curves be modified by, making an allowance of 20 deg. C. per horse-power of increased output, as deduced from the throttling tests, it appears that the valve temperature for a given output is sensibly independent of the compression ratio, as was also indicated by the curves of Fig. 14.

The corresponding curves of cylinder-head temperature show a small rise amounting to about 10 deg. C. for group E.V. over the whole range of compressions. When modified for the effect of the increased power at the higher ratios, these temperatures, for a given output, are also sensibly independent of compression ratio.

For comparison the results of similar tests on the modified cylinder—called cylinder A—are also shown on Fig. 15. The effect of the hotter head is shown in a reduction in power of about 10 per cent., and an average increase of 65 deg. C. in the valve temperatures in spite of the reduced output. The petrol consumption, which is sensibly the same at the lowest compression ratio, is 8 per cent. higher than in the standard cylinder at the highest ratio.

(11) *Speed of Rotation of Engine.*—Experiments on the standard cylinder have been carried out at full throttle and at speeds ranging from 1,500 r.p.m. to 1,800 r.p.m. with the results shown in Fig. 10. These refer to a compression ratio of 4·77. Experiments show that, so long as the spark advance is adjusted to give maximum power in each case, the effect of speed on valve temperature is sensibly independent of the compression ratio. Fig. 16 shows the results of tests on the modified cylinder at speeds from 1,200 to 1,700 r.p.m. These indicate a very appreciable increase in valve temperature with speed. The temperature rise per brake horse-power of increased output due to this cause is approximately 45 deg. The cylinder-head temperatures also rise with increasing speed, but at a much slower rate, the total increase in the standard cylinder between speeds of 1,500 r.p.m. and 1,800 r.p.m. being only 18 deg. C.

(12) *Spark Advance.*—The timing of the ignition has a very pronounced effect on the temperature of the exhaust-valve, and generally on the performance of the cylinder. The general effect of varying the timing is shown by the curves of Figs. 17 and 18, which represent the results of full-throttle tests with the weakest maximum load mixture.

The tests were carried out with a timing ranging from 20 deg. early to 45 deg. early, and show that for all compression ratios the lowest valve temperatures, the highest powers, and the minimum petrol consumptions are obtained with the spark as fully advanced as is possible without causing detonation. This best advance depends on the speed and compression ratio, but in the cylinder in question the whole available range could be used at all compressions up to 5·07 r.p.m. at 1,800 r.p.m. At 1,200 r.p.m. the best advance ranged from 45 deg. with a compression ratio of 4·0, to 30 deg. with a compression of 5·07.

The curves of Fig. 17 show the effect on valve and cylinder-head temperatures at one compression ratio and at different speeds, while Fig. 18 shows the effect at one speed and at different compression ratios. From these it appears that at all speeds from 1,500 r.p.m. to 1,800 r.p.m. the valve temperature is reduced by about 40 deg. C. as the spark advance is increased from 20 deg. to 45 deg. At the same time the cylinder-head temperature is increased by 5 deg. at 1,500 r.p.m. and by 7 deg. at 1,800 r.p.m. As the compression ratio is

* Paper read before the Institution of Mechanical Engineers on Friday, December 14, 1923.

increased, at a given speed, the effect of a variation in the timing diminishes slightly.

Experiments at half throttle show that the effect of a retarded spark in reducing the power is relatively even more marked than at full throttle, while the effect on the valve temperature is sensibly the same.

The effect of a variable-ignition timing, on the power, consumption, and maximum cylinder-head temperature is also shown by the figures of Table VI., which were obtained from full-throttle tests on a 5½-in. by 6½-in. aluminium air-cooled cylinder, Fig. 3 (page 785 *ante*), at 1,400 r.p.m., with an air temperature of 18 deg. C., and an 80 m.p.h. cooling wind. In these tests the spark advance was the only variable.

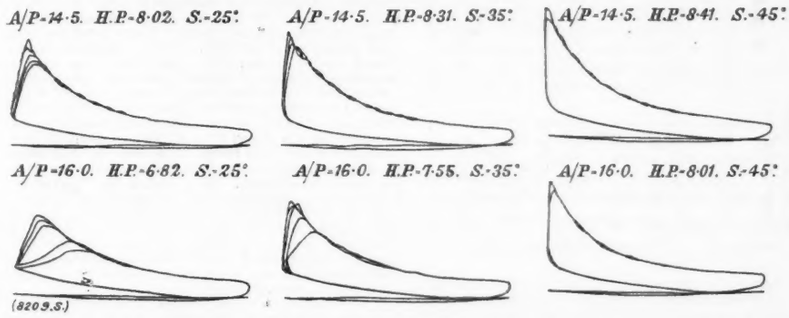
TABLE VI.

| B.H.P. | Petrol. Lb. per B.H.P.-hour. | Spark Advance. | Temp. of Cylinder Head. | Remarks. |
|---|---|---|---|---|
| | | Deg. | Deg. C. | |
| 30·5 | 0·575 | 21 | 215 | — |
| 31·2 | 0·498 | 26 | 216 | — |
| 31·6 | 0·492 | 30 | 221 | — |
| 31·6 | 0·492 | 36 | 245 | Occasional detonation. |
| 31·0 | 0·500 | 40 | 275 | Continuous heavy detonation. |

The figures show that so long as the spark advance is not so great as to produce detonation, it has very little effect on wall temperatures. Once continuous detonation is set up, however, the temperature shows a very appreciable rise.

The timing of the ignition has such a marked effect on the exhaust-valve temperature because it largely governs the type of combustion. The indicator diagrams, Figs. 19 and 20, were taken from the standard cylinder with a compression ratio of 4·77, at a speed of 1,600 r.p.m. and with spark advances of 25 deg., 35 deg. and 45 deg., the cards showing both normal and weak mixtures. With a spark advance of 45 deg. the explosion line is almost vertical, while as the spark is retarded the diagram becomes very flat and irregular, indicating late combustion, low efficiency, and an unduly hot exhaust.

*Figs. 19 and 20.* **INDICATOR DIAGRAMS TAKEN FROM THE STANDARD CYLINDER WITH A COMPRESSION RATIO OF 4·77, AT A SPEED OF 1,600 R.P.M., AND WITH SPARK ADVANCES OF 25°, 35° AND 45°.**




It should be emphasised that, from every point of view, it is advantageous to work with as great a spark advance as is feasible without causing detonation.

(13) *Spark-Plug Position and Inclination.*—The effect on exhaust-valve temperatures of the position, relative to the valve, of the sparking-plug has been referred to in connection with the tests on the air-cooled 5½-in. by 6-in. cylinder (Section 6*b*). In the A.S. cylinders two plug positions were provided at opposite ends of a diameter. As this diametrical plane is perpendicular to that containing the valve centres, these positions are symmetrical with respect to the exhaust-valve, so that the effect of a change of plug positions should be negligible. One of these plugs was, however, horizontal while the other was inclined at an angle of 35 deg. to the axis of the cylinder, and the effect of this inclination has been investigated.

The results show that the effect of the inclination of the plug on the power and consumption is very appreciable, especially with a spark not fully advanced. Table VII. shows typical results on cylinder A with a compression ratio of 4·22 at 1,670 r.p.m. and at full throttle.

TABLE VII.

| — | Spark Advance. | | | | | |
|---|---|---|---|---|---|---|
| | 20 deg. | | 37·5 deg. | | 45 deg. | |
| | I | H | I | H | I | H |
| Maximum B.H.P. | 7·9 | 8·7 | 8·7 | 9·2 | 9·2 | 9·3 |
| Petrol, pints per B.H.P.-hour .. | 0·80 | 0·726 | 0·726 | 0·674 | 0·686 | 0·680 |
| Exhaust valve temperatures, deg. C. | 795 | 780 | 775 | 760 | 760 | 750 |

In these tests, I refers to the inclined plug and H to the horizontal plug. At part-throttle the effect on power and petrol consumption is even more marked, as appears from the following results at about 70 per cent. of full load and with 45 deg. spark advance.

| — | B.H.P. | Petrol Consumption. Pints per B.H.P.-hour. | Exhaust-valve Temperatures. |
|---|---|---|---|
| | | | Deg. C. |
| Inclined plug .. .. | 6·1 | 0·740 | 725 |
| Horizontal plug .. | 6·55 | 0·680 | 725 |

Whether with petrol, or petrol-benzol mixtures, the horizontal plug always gives higher power on a lower petrol consumption, and with exhaust valve temperatures usually slightly lower and in no case higher.

(14) *Type of Plug.*—Three types of sparking-plug have been examined during the tests. These are the Lodge Aero, the K.L.G., and the Heath. There is very little difference between these as regards the performance of the engine. On the whole the exhaust-valve temperatures with the Lodge plug appear to be about 10 deg. lower than with either of the others. The effect on power and petrol consumption is inappreciable.

(15) *Influence of Jacket-Water Temperature.*—In the tests on the Armstrong-Siddeley cylinders the jacket water was usually supplied from the exhaust calorimeter whose temperature determined that of the jacket water inlet. In order to vary the temperature of the outlet water it was therefore necessary to vary the rate of flow, so that the effects of increased temperature and reduced velocity are combined in the results. Under these conditions tests carried out over the whole range of compression ratios and speeds are in agreement in showing that the temperature of the exhaust-valve increases uniformly with that of the outlet jacket water. A given increase in the latter temperature is accompanied by an average increase of 1·11 times this amount in the valve temperature. This ratio is almost independent of speed and compression ratio, increasing slightly with speed and diminishing slightly with an increase in the compression ratio.

In Cylinder A the best overall results, as regards power and petrol consumption, are attained with an outlet-water temperature of about 55 deg. C., as indicated by the following comparative results obtained with a compression ratio of 4·22 at 1,680 r.p.m., and with a maximum load mixture.

| J.W. temperature, deg. C. .. .. | 43 | 54 | 65 | 76 | 88 |
|---|---|---|---|---|---|
| B.H.P. .. .. | 9·37 | 9·40 | 9·38 | 9·34 | 9·20 |
| Petrol, pints per B.H.P.-hour .. | 0·656 | 0·653 | 0·656 | 0·658 | 0·666 |
| Exhaust-valve temperatures, deg. C... | 755 | 770 | 784 | 791 | 794 |

In the standard cylinder, with its better head cooling, the brake horse-power and consumption do not vary by more than 1 per cent. over the whole range of water temperatures, the reduced bearing and piston friction with the higher temperatures apparently compensating, almost exactly, for the reduced volumetric efficiency.

As shown by the following figures, which are taken from tests on the latter cylinder at 1,800 r.p.m., and with a compression ratio of 4·77, the temperature of the cylinder-head also increases uniformly with an increase in the jacket-water temperature. The range of temperature of the cylinder-head is, however, only one-third of that of the exhaust-valve, and slightly less than one-third of that of the outlet jacket water.

| J.W. temperature, deg. C. .. .. | 60 | 70 | 80 | 90 | 95 |
|---|---|---|---|---|---|
| Cylinder-head temperature, deg. C.: | | | | | |
| Group E.V. .. | 190 | 192·5 | 195 | 197·5 | 199·5 |
| ,, C.H. .. | 178 | 181 | 184 | 187 | 189 |
| ,, I.V. .. | 163·5 | 166·5 | 169·5 | 172·5 | 174 |
| Exhaust-valve temperatures, deg. C. | 708 | 717 | 726 | 735 | 740 |

These figures are of interest as showing :—

(*a*) The comparatively small effect on the cylinder head temperature of an increase in the jacket-water temperature.

(*b*) The difference in temperature between the cylinder-head and the cooling water at its outlet from the cylinder. This difference diminishes as the temperature increases, but if the mean head temperature C.H. be taken as the criterion, is still 94 deg. C. at the highest water temperatures. These cylinder-head temperatures are no lower than are obtained in normal operation with a well-designed air-cooled cylinder of the same size.

(*c*) That the great reduction in valve temperature, accompanying a reduction in cooling-water temperature, is only to a small extent due to the direct cooling effect of the valve-seat. Actually the results show that as the temperatures of the jacket-water and the valve are reduced, the difference in temperature between the valve and its seat is also reduced, so that the heat lost by conduction in this way is greater with a hot seat (and a correspondingly hot valve), than with a cool seat and with the corresponding cooler valve.

The explanation of these somewhat paradoxical results is to be found in the fact that the indicated thermal efficiency of the engine diminishes with an increase in wall temperature, due apparently to a reduction in the rapidity of combustion. This reduces the explosion temperature, and the amount of heat given to the jackets, but increases the temperature of the exhaust gases, as is shown by the following figures obtained from the standard cylinder. In these tests the weight of exhaust gas per minute was obtained from measurements of the air and petrol supplied, while the amount of heat in the exhaust per minute was obtained from measurements on the exhaust calorimeter. From these measurements the temperature of the exhaust is readily calculated. At the same time the heat given to the jacket-water was deduced from measurements of its quantity and of its rise in temperature.

| J.W. temperature, deg. C. .. .. .. | 60 | 70 | 80 | 90 | 95 |
|---|---|---|---|---|---|
| Temperature of exhaust gases, deg. C. .. | 998 | 1,020 | 1,045 | 1,062 | 1,073 |
| Heat to jacket-water C.H.U., per minute .. | 262 | 257 | 252 | 247 | 244 |

The results would appear to indicate that the phenomenon of combustion is sensitive to comparatively small changes of temperature in the cylinder walls. Some indication of this had already been obtained by one of the authors in tests of air-cooled cylinders. No ready explanation of the phenomenon offers itself, and it is hoped to investigate this point in further research on the engine.

(16) *Position of Jacket-Water Inlet.*—Three positions of jacket-water inlet were provided on the standard A.S. cylinder : (1) The normal position near the base of the jacket on the port side ; (2) a position about 1⅝ in. below the level of the cylinder crown on the side opposite the ports ; and (3) about 1 in. above the level of the cylinder crown on the port side, centrally placed between the valve-ports. The outlet in all cases was over the head of the cylinder on the port side. It was found that the effect of the different positions on the valve temperature was in favour of (2) as against (1), and of (3) as against (2), the positions (1) and (2) giving temperatures respectively 16 deg. and 10 deg. higher than the upper position.

The corresponding variation of mean cylinder head temperature was less marked, the maximum range being only about 3 deg. C. Considering the thermo-couple readings separately, however, a considerable difference was found, position (3) giving the greatest variation across the head. The incoming water in this case appeared in part to be thrown upwards by the bridge piece formed by the junction of the valve-ports, while the water on its way to the outlet probably passed close under the jacket-cover. The result was a very marked pocket of water surrounding the couple L, the temperature of the water at this point frequently being 16 deg. C. above the temperature of the outlet water. The effect of this pocket was more or less apparent for all the water-inlet positions, owing to the effect of the valve-ports and the extra sparking-plug boss.

The combined results of pocketing in the water-jacket and uneven heat reception from the gases, produced a wide range of temperature over the cylinder-head, couple G giving the lowest temperature and D the highest. The difference of temperature between these couples varied slightly, the average value being over 50 deg. C., with a maximum of 58 deg. The temperature at I, where the metal thickness was a maximum, was also high, but some 16 deg. C. less than D. The temperature was reduced some 3 deg. C. when the hot-water supply to the induction pipe manifold was cut off, and was further reduced about 3 deg. C. for very strong or very weak mixtures.

An attempt to direct the incoming water to the hottest parts of the cylinder by means of baffles was only partially successful in equalizing the head temperatures, the spaces in the jacket being too large for the proper direction of small quantities of water. By continuing the inlet pipe over the cylinder-head and directing jets of water into pockets L and A, an appreciable improvement was, however, effected, the temperature difference being reduced some 17 per cent.

During these trials the temperature of the exhaust-valve guide followed the general trend of cylinder-head temperatures, being some 12 deg. to 20 deg. lower than the general mean of the head. It was noticed in the course of these experiments that there is a difference of 20 deg. to 30 deg. C., between the temperatures of opposite sides of the valve-head, near the seat. The hottest side is towards the centre of the cylinder, corresponding to the hottest part of the valve-seat. This is probably due partly to the fact that the seat is hottest at this

point, and partly to the fact that access to the valve from the body of the cylinder is freest and that more than a due proportion of the hot gases escape over this sector. Observation showed that the exhaust valves seldom turn round while in operation.

(17) *Comparison of Tests on Single-and Multi-Cylinder Engines.*—By the courtesy of Messrs. Armstrong Siddeley Motors, Ltd., the authors have been enabled to make exhaust-valve temperature measurements on a test-bed at their Coventry works on a six-cylinder car engine having cylinders of the same design as those of the standard single cylinder, and the comparison between the behaviour of the single- and multi-cylinder engine is of interest. Measurements were made on the latter engine with a compression ratio of 4·25 at 1,700 r.p.m. at full throttle, and with the carburettor adjusted to give a normal maximum load mixture. Under these conditions the results were :—

| B.H.P. | J. W. outlet Temperature. | Spark Advance. | Exhaust-Valve Temps. | |
|---|---|---|---|---|
| | | | No. 2. | No. 4. |
| | Deg. C. | Degrees. | Deg. C. | Deg. C. |
| 47·0 | 70·5 | 6 | 750 | 720 |
| 60·2 | 70·5 | 36 | 700 | 680 |

From the figures available on the single-cylinder unit, it appears that under the same conditions the results would be approximately :—

| Spark Advance. | B.H.P. | Exhaust-Valve Temperatures. |
|---|---|---|
| Degrees. | | Deg. C. |
| 6 | 8·2 | 770 |
| 36 | 10·2 | 710 |

From the tests it appears that the effect of spark advance on power, consumption and valve temperature is of the same order in both engines. With the spark advanced to 36 deg. the power per cylinder in the six-cylinder engine is about 7 per cent. less than in the single cylinder, a result in general agreement with other comparative tests on single- and multi-cylinder engines. The difference is probably due to unequal distribution in the multi-cylinder engine. This conclusion is rather borne out by the exhaust-valve temperature measurements. The valves in cylinders 2 and 4 were distinctly hotter than the remainder, indicating that the other cylinders were operating on a stronger mixture. It will be noted that the valve temperatures in the hottest cylinder (No. 2) are almost identical with those on the single cylinder. A further comparison between exhaust valve temperatures in a single- and multi-cylinder engine is given in Section 6 (*d*).

(18) *Shape of Valve-Head and Width of Valve-Seat.*—Three shapes of exhaust-valve head were examined during the tests on the A.S. cylinder A. These were (*a*) the standard valve having a tulip-shaped head ; (*b*) a valve having a flat under surface, and a tulip-shaped top similar to the standard ; (*c*) a valve of normal flat-head design.

The results show that the valve having a flat bottom and a tulip-shaped top gives about 1 per cent. more power than the standard valve, and that its maximum temperature is then slightly (about 10 deg.) lower. It is, however, appreciably heavier than the standard valve. The valve with a head which is flat both top and bottom gets distinctly hotter (about 40 deg.) than either—not in the head, but in the stem at about 1 in. above the head. This valve ultimately seized in the valve-guide. Until it seized, it gave sensibly the same results as the other flat-bottomed valve, both as regards power and petrol consumption.

In the cylinder as originally constructed, the width of valve-seat was 0·05 in., and it was anticipated that some reduction in valve temperature might follow a widening of the seat. Comparative tests with seat widths of 0·05 in. and 0·10 in., however, show that the wide seat gives a slightly hotter valve. On examining the valve and its seat after the tests, it was found to be perfectly bedded, so that this result cannot be attributed to imperfect contact. A possible explanation would appear to be that while the increased area of contact must in itself facilitate the transfer of heat from the valve to its seat, the modification in the form of the channel through which the gas escapes when the valve first leaves its seat, and when in consequence the exhaust gases have their maximum density and temperature, increases the area exposed to the direct scour of the gases to an extent which more than counterbalances the effect of the subsequent cooling.

(19) *Effect of Valve-Lift.*—Experiments were also carried out on the same cylinder to determine the effect on exhaust-valve temperatures of a variation in the valve-lift, which was increased in two stages from 0·215 in. to 0·312 in., the normal lift being 0·280 in. Over this range the increased lift increased the maximum power developed at 1,700 r.p.m. by 3 per cent. At the same time the maximum valve temperature was reduced by 30 deg. C.

(20) *Effect of Valve-Tappet Clearance.*—Any increase in the positive clearance of the exhaust-valve tappet increases the time during which the valve is in contact with its seat, and, by delaying the instant of opening to a point later on the expansion stroke, gives a cooler exhaust. For these reasons it should tend to give a cooler exhaust-valve. On the other hand the increased clearance gives a reduced valve-lift, and thus a higher mean gas velocity, which in itself, as indicated in the preceding section, would tend to produce a higher valve temperature.

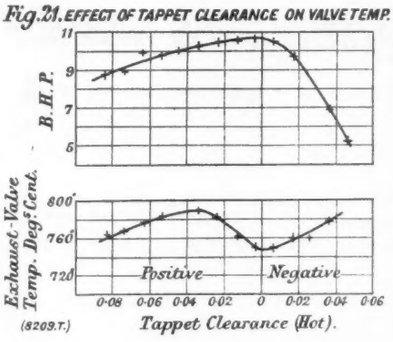
With a negative clearance the valve is never in contact with its seat, and the total absence of any cooling due to such contact, and the fact that during the hottest parts of the cycle it is exposed to the scour of escaping gases, will tend to give a very hot valve. On the other hand, the brake horse-power is appreciably reduced with negative clearances, and this, combined with the influx and efflux of comparatively cool gases past the valve during the suction and compression strokes, will tend to reduce its temperature.

In the Armstrong-Siddeley cylinders, the tappet clearance can be adjusted while the engine is running, and in order to determine the net effect of these factors, experiments were carried out on both cylinders, over a wide range of positive and negative clearances. The results of these as obtained from the standard cylinder at a speed of 1,800 r.p.m. and with a compression ratio of 4·26 are shown in Fig. 21. In these tests temperatures were measured in the usual place, where the stem joins the head of the valve. The clearances given were measured immediately on stopping the engine, with the cylinder hot.

The results show that, starting with a large positive clearance of 0·080 in., the temperature gradually rises as the clearance is reduced, and attains a maximum when the clearance is 0·035 in. As the clearance is further reduced the temperature decreases, in spite of the increased brake horse-power, and attains a minimum value when the clearance is zero. With negative clearances the temperature increases with the amount of the clearance within the limits of the tests (up to 0·035 in.). Over a range of clearances from 0·010 in. to —0·015 in., however, the effect of clearance was only small, not exceeding 10 deg. C.

In tests on cylinder A a curve of similar form was obtained, but in this case the minimum point was attained

*Fig. 21. EFFECT OF TAPPET CLEARANCE ON VALVE TEMP.*




with a negative clearance of 0·009 in. The difference is probably due in part to the fact that the tests on this cylinder were carried out with an open exhaust, and that in consequence the gases drawn past the exhaust-valve with a negative clearance, on the suction stroke, would be appreciably cooler than with the normal arrangement of the exhaust-pipe in the tests on the standard cylinder. Both tests are, however, in agreement in showing that over a range of clearances varying from + 0·015 in. to — 0·015 in., the effect of clearance on valve temperature is only small (not exceeding 20 deg.).

Tests on both cylinders at speeds from 1,500 to 1,800 r.p.m. show that the effect, for clearances up to ± 0·020 in., is practically independent of the speed over this range. In cylinder A temperatures were measured at the usual point, at the junction of the valve-head and stem, and also at a point about ¼ in. distant from the edge of the valve. So long as the tappet has any positive clearance these temperatures agree within 10 deg. C., but as the clearance is made increasingly negative, the latter temperature becomes increasingly greater than the former, as indicated by the following results :—

| Clearance. | 0·01 | 0·00 | —0·005 | —0·010 | —0·015 |
|---|---|---|---|---|---|
| | Deg. | Deg. | Deg. | Deg. | Deg. |
| Difference in Temperature between edge and centre of valve-head | —5 | 5 | 18 | 37 | 58 |

(21) *Effect upon Valve Temperature of Loss of Heat to the Seat and Valve-Guide.*—Though no quantitative measurements have been made of these losses, a few tests have been carried out under circumstances which tend largely to reduce their magnitude. As previously mentioned, the temperature of the valve, except in cases of negative clearance, is usually somewhat less near the seat than at a point nearer the stem, and the valve-guide has a similar chilling effect, the stem generally running almost black at the entrance to the guide.

Measurements of valve temperatures on cylinders having loose valve-seats have already been recorded (cylinders (*a*) and (*b*) ), the result in both cases being an appreciable increase in valve temperature.

In a series of tests carried out on the A.S. Standard cylinder to determine the cooling effect of the guide, the bronze guide which had been used during the previous tests was driven from the cylinder and its externa diameter was reduced, leaving only enough of the original cylindrical surface to register the guide in the cylinder-head. It was then replaced, mica washers being inserted between the cylinder and the collar and tightening nut on the guide. Under these circumstances the valve-head ran about 22 deg. C. hotter than previously, the stem at the entrance to the guide being only about 50 deg. below the temperature recorded on the back of the head.

(22) *Type of Fuel.*—In the majority of the tests Pratt No. 1 petrol was used as the fuel but a number of runs were made on a mixture of 80 per cent. Pratt No. 1 and 20 per cent. benzol. Except at the highest compression ratios, at which detonation occurred with petrol, and not with the benzol mixture, the effect on the performance of the engine was very slight. With a compression ratio of 4·26 at 1,670 r.p.m., petrol gives about 1½ per cent. more power than the benzol mixture, with a fully retarded spark, and about 3 per cent. less power with a fully advanced spark. The exhaust valve is about 5 deg. cooler with petrol than with the benzol mixture, with a fully retarded spark, and about 5 deg. hotter with a fully advanced spark.

With a 5·2 ratio the maximum power obtainable with the benzol mixture was 3·5 per cent. greater than with petrol, and the maximum exhaust-valve temperature was sensibly the same as with petrol. The results of typical comparative tests on the two fuels are shown in Fig. 18.

(23) *Water-Cooled Exhaust-Valves.*—It is evident that the presence of an exhaust-valve head at a temperature between 700 deg. C. and 800 deg. C., as part of the combustion space of a cylinder, cannot but be detrimental to the successful operation of the cylinder. It forms a hot spot of considerable area, which reduces the volumetric efficiency, and, by facilitating detonation and pre-ignition, reduces the compression ratio at which satisfactory operation is possible, and thereby reduces the possible thermal efficiency. As the cooling effect of the valve-seat and guide is inversely proportional to the diameter, the difficulty of cooling will be more serious as the size of exhaust-valve is increased.

In order to determine the effect of cooling the valve, a series of cooled exhaust-valves were made at the Royal Aircraft Establishment, and were tested by one of the authors. These were of the types shown in Fig. 22, page 819. In Nos. 1–3 the valve-stem is hollow, and at its upper end exposed to an air-blast, carries a series of cooling fins, turned out of the solid. In No. 3 the valve-head was bored out as shown, and a steel plug was afterwards welded in position to complete the head. The upper end of the stem is provided with a screwed plug which is also welded in position, and is tapped for a small screw. The valve-stem is filled to one-third its capacity with water, and the valve is placed in an oil bath at about 120 deg. C. until the water boils freely. The screw is then inserted, and immediately welded in position, so that the whole is perfectly steam-tight. In operation the heating of the valve-head evaporates some of the water, which condenses on the cooled upper surface of the valve-stem and trickles down its interior to be re-evaporated, and in this way, with a suitable adjustment of the area of cooling surfaces and of the valve-head, the maximum temperature of the latter may be kept down to about 300 deg. C., or even lower.

When carefully welded, types (1) and (2) proved perfectly satisfactory in operation. Type (3) was unsatisfactory, owing to the difficulties of making a welded joint in the head of the valve which would stand up to the internal pressure and the inertia forces and vibration. In type (4) an aluminium alloy rod with cooling fins at its upper end was fitted tightly into the hollow stem, and was riveted over at the under side of the head. This type proved useless, as after a very short time the rod became slack and its lower end burnt away.

Such valves were used with a split valve-guide, of the type shown in Fig. 22, and a forked rocker arm. They have the disadvantage that their weight is greater than that of the normal valve.

Valves 1 and 2, which were 42 mm. in diameter, weigh 5·5 oz., as compared with 4 oz. for the normal uncooled valve, while the weight of the valve springs, rocker lever, and guide complete is 26·5 oz., as compared with 14·5 oz. for the corresponding parts in a normal cylinder. These valves have twelve steel fins, 1·1 in. outside diameter, providing a cooling area of 21·5 square inches, including the extra length of stem.

(24) *Tests on Water-Cooled Valves.*—The valves were tested on a unit having a single aluminium air-cooled cylinder 100 mm. bore by 140 mm. stroke, Fig. 1, under compression ratios varying from 4·7 to 6·2. The temperature of the head at a point 0·6 in. from the seat (approximately the hottest point of a normal valve) was measured under various conditions. To obtain these temperatures the engine was run with open exhaust until all conditions were steady. The pin in the exhaust rocker lever was then pulled out, and a brake applied to the fly-wheel, pulling the engine up dead. A Pt. Ir. thermo-couple was then inserted into a ¼-mm. hole drilled into the valve-head, and the temperature was recorded at intervals of 5 seconds. A cooling curve was obtained in this way which, when produced backwards through the axis of zero time, was assumed to give the temperature at the instant of stopping. The temperatures so obtained range from 250 deg. C. to 320 deg. C., and while not exact are probably correct within about 15 deg. C. The higher temperatures were obtained with a 5·5 compression ratio, and the lower with a 4·7 ratio. The same cylinder was afterwards tested with an uncooled valve. Similar tests were also carried out on an aluminium air-cooled cylinder 5½ in. diameter by 6½ in. stroke, with a single exhaust valve 2·3 in. diameter, Fig. 3.

The results of typical tests are shown in Table VIII on the next page.

In the first series the temperature of the upper end of

the valve-stem was approximately 70 deg. C. lower than that of the head. Temperature measurements on the cylinder-head and piston showed that under maximum load conditions, with a 5·5 compression ratio, the mean temperature of the cylinder-head was reduced by 26 deg. C. by the external cooling of the exhaust-valve; that the temperature difference between the exhaust and inlet side of the combustion space, and hence the tendency to distortion, was appreciably reduced; and that the hottest point of the piston was 25 deg. cooler with the cooled valve in operation.

The results of a large number of tests show that as a net result of the cooling an average increase of 2½ per cent. in the maximum power is obtained, while the maximum power obtainable with an uncooled valve can be developed with a cooled valve, on a petrol consumption about 8 per cent. less than with the uncooled valve.

The cooled valve is relatively more advantageous at the higher compression ratios. It notably reduces the tendency to detonation and enables a higher compression ratio to be utilised.

While the experiments show that water-cooled valves of this type are capable of giving excellent results, care must be taken in the design, to ensure that the cooling surface on the valve-stem is adequate. The critical temperature of water is approximately 374 deg. C., and if, owing to inadequate cooling, the temperature of the water attains this value, the whole of it will be turned into steam. Under these conditions, assuming the valve-stem to be originally one-third full of water, the volume of the steam would be three times that of the water from which it was formed, and its density would be 20·8 lb. per cub. ft., corresponding to a pressure of approximately 4·5 tons per sq. in. In one of the tests on the large valve, Table VIII, the speed of the cooling air was reduced until this action did occur, with the result that a bubble was blown on the lower portion of the valve stem. From a knowledge of the diameter and thickness of the stem, and of the tensile strength of the material, it was calculated that the internal pressure must have been of the order of 4 tons per sq. in.

*Fig. 22.* COOLED EXHAUST-VALVES, MADE AT THE ROYAL AIRCRAFT ESTABLISHMENT.

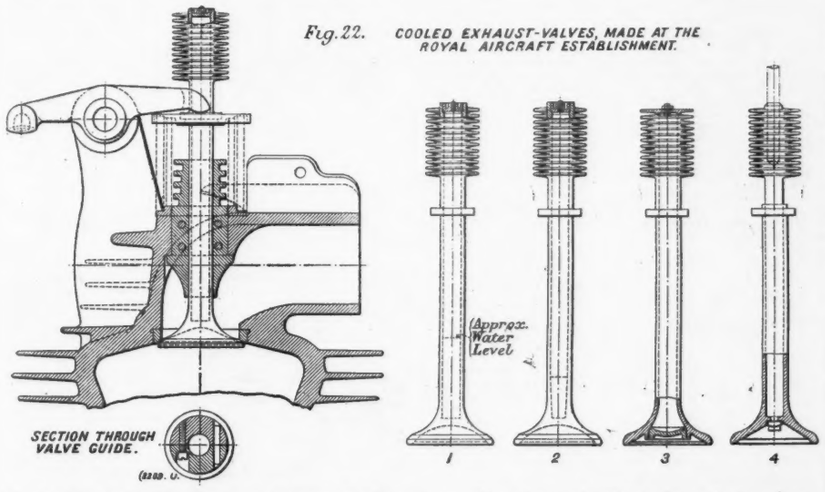



TABLE VIII.

| Cylinder. | Revs. | Comp. Ratio. | B.M.E.P. | Petrol. Lb. per B.H.P.-Hour. | Temp. of Valve. | Remarks |
|---|---|---|---|---|---|---|
| | | | | | Deg. C. | |
| 100×140 mm. single aluminium Cylinder (Fig. 1). Exhaust-Valve 42 mm. diam. in port. | 1,800 | 4·7 | 126·0* | 0·535 | 260 | Water-cooled valve. |
| | ,, | ,, | 121·0 | 0·498 | 270 | |
| | ,, | ,, | 121·0* | 0·538 | 700 | Uncooled valve. |
| | 1,800 | 5·5 | 133·5* | 0·534 | 300 | Water-cooled valve. |
| | ,, | ,, | 130·0 | 0·480 | 310 | |
| | ,, | ,, | 127·5* | 0·559 | 750 | Uncooled valve. |
| | ,, | ,, | 123·5 | 0·511 | 770 | |
| 5½ in. × 6½ in. single aluminium Cylinder. Exhaust-Valve 2·3 in. diam. in port (Fig. 3). | 1,650 | 5·0 | 117·0* | 0·545 | 400 | Water-cooled valve. |
| | ,, | ,, | 116·0 | 0·470 | — | |
| | ,, | ,, | 113·9 | 0·448 | — | |
| | ,, | ,, | 113·4* | 0·561 | 760 | Uncooled valve. |
| | ,, | ,, | 111·6 | 0·489 | 790 | |

* Maximum load conditions.

In general it may be taken that with a cooling wind of 60 m.p.h. and with steel fins of the dimensions and pitch shown in Fig. 22, the cooling area of the fins for high-duty air-cooled aero-engines should be at least ten times the area of the valve-head. For other wind speeds, the cooling area should be inversely proportional to $V^{0.78}$. This cooling allowance will keep the valve-head at a temperature of approximately 300 deg. C. In order to avoid the danger of exceeding the critical temperature of the cooling fluid, other fluids than water have been suggested. Aniline (B.P. 184 deg. C.) was tried, but was found to decompose after a short period of operation. Mercury (B.P. 358 deg. C.) was also tried. This, however, is extremely heavy, and since its cooling effect does not become marked until its boiling-point is reached, the valve is appreciably hotter than with water.

It is probable that some of the fusible salts might give fairly good results. The authors understand that a mixture of sodium and potassium nitrates (melting-point 241 deg. C.) has recently been used successfully in the United States.*

(25) *Conclusions.*—The investigation goes to show that, in a well-designed and well-cooled overhead-valve petrol-engine, either of the air-cooled or water-cooled type, under normal conditions of operation the temperature of the exhaust-valve may be between 600 deg. C. and 750 deg. C. The temperature is affected by a large number of factors, the most important, in an engine operating without detonation, being the timing of the ignition, the temperature of the cooling water, and the strength of the working mixture. The highest temperatures under such conditions are attained at full throttle with the weakest mixture capable of maintaining maximum load, with the highest jacket-water temperature, and with a retarded ignition.

In a given cylinder, with different compression ratios, the exhaust-valve temperature at any given horse-power within the capacity of the cylinder having the lowest compression ratio, is sensibly independent of the compression ratio.

If, owing to some such hot spot in a cylinder as may be produced by the action of a loose valve-seat or of a defective sparking-plug, pre-ignition is set up, the temperature of an exhaust-valve may readily attain temperatures exceeding 800 deg. C. At such temperatures the valve, whether of chromium or tungsten steel, will rapidly burn out. At lower temperatures chromium steel has the advantage of not oxidising so rapidly as tungsten steel with weak mixtures, although at temperatures not exceeding 750 deg. C. both are capable of giving excellent results.

The best shape of valve-head appears to be one having a flat bottom and a tulip-shaped top. Owing to the weight, this is in general impracticable, and the next best is one having the tulip-shaped head common in aero-engine practice. Increasing the lift of the valve within limits tends to cool operation by reducing the mean scouring velocity of the gases.

Within the limits usual in practice, tappet clearance does not greatly affect valve temperatures. Even negative clearance, so long as this does not exceed about 0·010 in., has only a small effect.

Generally speaking, the conditions tending to give a hot valve also tend to give a hot cylinder-head. The result of retarding the ignition is exceptional in that it gives a hot valve but a cool head. The range in cylinder-head temperatures corresponding to a given change in operating conditions is, however, much smaller than the range of temperatures of the exhaust-valve.

Valve temperatures are sensibly the same whether petrol or a petrol-benzol mixture is used as a fuel. In this connection benzol is only of real advantage under conditions in which the use of petrol would be accompanied by serious detonation leading to pre-ignition.

By water-cooling exhaust-valves the temperature can be reduced to about 300 deg. C., and such valves enable the output and efficiency of an engine to be appreciably increased. They also enable a higher compression ratio to be used. They are, however, only suitable for use on an air-cooled engine, and if water is used as the cooling fluid, unless carefully designed, are likely to prove a source of danger.

In conclusion, the authors would express their sense of indebtedness to the Director of Research, the Air Ministry, for permission to incorporate in the paper the results of the measurements made at the Royal Aircraft Establishment.

* By Mr. D. Heron.

## CATALOGUES.

*Rock Drills.*—A number of test results in competition between their own and other makes of rock drills are published in a booklet issued by the Hardy Patent Pick Company, Limited, Sheffield.

*Electrical Apparatus and Machinery.*—A pamphlet of 32 pages containing a brief illustrated description of their principal products has been issued by the General Electric Company, Limited, Kingsway, London, W.C. 2.

*Electric Light Fittings.*—Catalogues of lanterns and fittings for gas-filled lamps and a circular notifying a reduction of prices in ironclad switch gear, are to hand from the Foster Engineering Company, Limited, Wimbledon, London, S.W. 19.

*Electric Heating Panels.*—Radioelectric panels for warming rooms made up in portable form as mats, fire screens, draught screens, &c., or applied as fixed wall or partition panels are described in a catalogue received from Messrs. Grierson, Limited, 43, Bloomsbury-square, London, W.C. 1.

*Mechanical Stokers.*—The underfeed stoker made by the Westinghouse Electric and Manufacturing Company, Philadelphia, U.S.A., is described in a special catalogue recently received from that firm. The catalogue contains many excellent illustrations of the stoker, including two sectional drawings showing its application to water-tube boilers.

*Constructional Engineering.*—Illustrations with brief particulars of work executed, including bridges, dock gates, workshop buildings, transporters, cranes, rotary tunnel cutting machines, and many heavy machine tools used in connection with this class of work have come to hand from Messrs. Sir William Arrol and Co., Limited, Glasgow.

*Sluice Gates.*—We have received a catalogue of sluice gates and penstocks for sea outfalls, water supply works, sewage disposal works, power plants, &c., from Messrs. Ham Baker and Co., Limited, Langley-green, Birmingham. Some fine examples of large scale constructional work executed by the firm are illustrated, and the catalogue deals with all the gearing and accessories for all sizes in common use.

*Electric Control Gear.*—A new catalogue of alternating-current control gear, supplementary to their general catalogue, has been issued by Messrs. Veritys, Limited, Aston, Birmingham, giving illustrations and descriptions of a considerable range of starters, controllers and speed regulators for electric motors. Prices are stated, with the necessary technical and transport particulars. A priced list of lanterns and reflectors has also come to hand.

*Stress Determination by Polarised Light.*—Messrs. Adam Hilger, Limited, 75A, Camden-road, London, N.W. 1, send a circular of the apparatus designed by Professor E. G. Coker for determining the stress distribution in structures and machine parts by observation of models made of transparent material. Coloured illustrations of model test-pieces showing the stress effects and a list of books and papers on the subject is given in the circular.

*Electric Motors.*—A new edition of their catalogue of electric motors, first published in 1903, is to hand from Messrs. Lawrence, Scott and Co., Limited, Norwich. The prefaces to previous editions are reprinted, and these are followed by sections relating to shunt motors, adjustable speed motors, interpole machines, series motors, compound motors, starting and regulating switches and other details. The explanatory matter of this catalogue is particularly clear and concise.

*Electric Drive.*—A pamphlet of 40 pages devoted to a description of the Holmes-Clatworthy system of driving newspaper printing machines, of the rotary or flat bed types, is to hand from Messrs. J. H. Holmes and Co., Limited, Portland-road, Newcastle-on-Tyne. A commendable effort is made to state the main conditions which have to be complied with and to explain the various methods of driving in terms which the printer will appreciate. A long list of establishments in which the firm's system of driving has been adopted is also included.

*Steam Turbines.*—The Terry steam turbine is very fully described and illustrated in a special catalogue dealing with the non-condensing and condensing types, and with the reduction gear. The section relating to condensing turbines is sub-divided into parts dealing with high, low, and mixed-pressure types and the form in which steam, after doing work in the turbine, is taken off for heating or other purposes. A number of sets applied to electrical generation, pumping, blowing, &c., are illustrated. The makers are the Terry Steam Turbine Company, Hartford, Conn., U.S.A., and the sole agents in this country are Messrs. J. Golder and Co., 10, Broad-street-avenue, London, E.C. 2.

*Gas Engines.*—Vertical double-acting tandem gas engines, especially suitable for working on the waste gases produced in iron and steel works, are described in a catalogue received from the Premier Gas Engine Company, Limited, Sandiacre, near Nottingham. A sheet of line drawings shows vertical sections of engine and foundations. These engines run at slow speeds and are made in large sizes, from 1,000 h.p. up to 3,000 h.p. They have four cylinders arranged in two pairs in tandem, with connecting rods to one crank which receives four impulses per revolution. Sets may be constructed with two to four cranks developing two to four times the powers stated. These engines compete directly with the foreign horizontal tandem gas engines which have had a large sale in this country.

# "ENGINEERING" ILLUSTRATED PATENT RECORD.

## SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACTS OF 1907 AND 1919.

*The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.*

*Where inventions are communicated from abroad, the Names, &c., of the communicators are given in italics.*

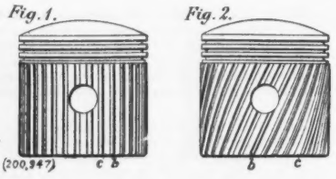
*Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 1s.*

*The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.*

*Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.*

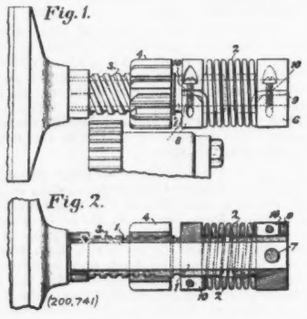
### GAS ENGINES, PRODUCERS, HOLDERS, &c.

**200,947. Rudge-Whitworth, Limited, Coventry, and T. B. Barrington, Coventry. Pistons.** (8 *Figs.*) April 20, 1922.—The invention relates to trunk pistons of the type in which the external surface of the wall or skirt is so constructed as to provide recesses or grooves which divide up the area in contact with the internal surface of the cylinder. The invention consists in providing bearing surfaces by means of straight or




spiral longitudinal ribs or raised portions *c* formed by milling or cutting a number of grooves *b* in the circumferential surface of the material forming the piston, so that with or without further subdivision the bearing surface constitutes a number of such smaller areas interspersed by oil channels as to reduce substantially the frictional losses due to shearing the film of oil between piston and cylinder. (*Sealed.*)

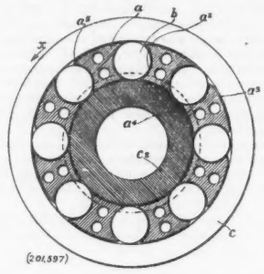
**200,741. W. Holt, Oldbury, and Broit, Limited, Oldbury. Starters for Internal-Combustion Engines.** (7 *Figs.*) September 25, 1922.—The invention relates to starters for internal-combustion engines of the type comprising an electric motor having a shaft which transmits its drive to an auxiliary shaft through the medium of a coupling spring, the auxiliary shaft carrying a pinion arranged to gear with the flywheel upon the engine shaft. The invention consists essentially in bending the end of the spring in the longitudinal direction of the spring and engaging and securing it within a slot in the collar to which it is to be connected, so that neither the said end of the spring nor the connecting means project beyond the periphery of the collar. The spring 2 connecting the two shafts 1, 3 is arranged to surround the outer end of the armature shaft 1 and is attached at its one end to a collar 6 fixed upon the outer end thereof by a pin 7, the spring being secured at its opposite end to a collar 8




integral with the outer end of the auxiliary shaft 3. The collars 6, 8 are of a diameter equal to that of the toothed pinion 4, and, according to the invention, the ends of the spring 2 are attached to the respective collars in the following manner: Each of the collars 6, 8 is formed in its periphery with an open-ended transverse and radially-directed slot 9, and the ends 10 of the spring 2 are each bent up so as to lie in a plane substantially parallel to the axes of the two shafts, the bent-up ends 10 of the spring being engaged edgewise within the slot 9 in the respective collar. Each slot 9 is of a depth approximately equal to the width of the bent-up end of the spring 2, so that the outer edge of the end 10 comes flush with the periphery of the respective collar. The periphery of each of the collars 6 and 8 is cut away or gapped, at a point adjacent to the transverse slot 9, so as to form a transverse rib, or lug, this lug being formed with a transverse screw-threaded hole for the reception of a screw which is arranged to pass through a hole in the respective end 10 of the spring and to engage with a hole in the opposite side of the slot 9. The end of the spring 2 is thus securely held within the latter, whilst the head of each screw lies within the recess in its collar. Neither the spring nor its securing means, therefore, extends beyond the periphery of the collars 6, 8, so that consequently they do not project beyond the periphery of the toothed pinion 4. (*Sealed.*)

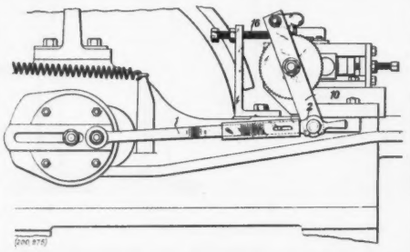
### MACHINE AND OTHER TOOLS, SHAFTING, &c.

**201,597. H. C. MacL. Stevens, Wolverhampton, L. Coatalen, Wolverhampton, and Sunbeam Motor Car Company, Limited, Wolverhampton. Anti-friction Bearings.** (2 *Figs.*) April 3, 1922.—The invention relates to anti-friction bearings of the ball or roller kind in which distance-pieces or separators are arranged between each pair of rolling elements. The separators are in the form of blocks *a* located between the rollers *b* and having hollow curved faces $a^2$ where they abut the rollers so that the latter lie against these curved parts and have



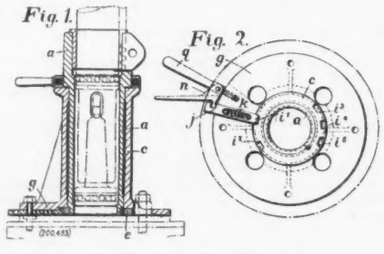

ample bearing in them. The respective faces $a^3$, $a^4$, of the block against the outer and inner races *c* and $c_2$ are curved to agree with the races so that they take a substantial bearing upon them, and the width of the block between the two races is such that working clearance is provided. The leading edges $a^5$ of the distance-pieces *a* are slightly bevelled on the surfaces which would otherwise touch the race so as to provide a clear lead for the entry of lubricant between the rubbing surfaces when the bearings rotate continuously in the same direction (here shown by the arrow *x*). (*Sealed.*)

**200,975. A. H. Smith, Birmingham. Power Presses.** (1 *Fig.*) May 18, 1922.—The invention relates to automatic feeding devices primarily intended for feeding strip material to power presses. The invention relates to automatic feeding devices for power presses having a reciprocating rod actuating an oscillating lever carrying a pawl and ratchet mechanism




adapted to give a step-by-step motion to the shaft upon which the ratchet wheel is mounted. According to the invention, the reciprocating rod is made in two portions 1, 2, which can slide with respect to each other so that the effective length of the rod can be altered as required, whilst the oscillating lever 10 has its stroke determined by a positive and adjustable stop 16. (*Accepted August* 1, 1923.)

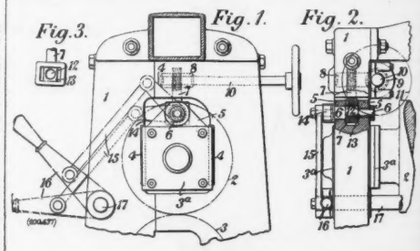
**200,453. G. Hey, Luton, and Adamant Engineering Company, Limited, Luton. Multiple Spindle Drill Heads.** (2 *Figs.*) March 1, 1923.—The invention relates to an improved




support or adapter for multiple spindle drillheads. The invention provides a support or adapter comprising a central tubular part *a* which is constructed so that it can be conveniently fixed to a drilling or like machine, and a sleeve *c* mounted to rotate on the tubular part *a* and provided with a flange *g* for carrying the drill head. A flange *e* is screwed on to the body *a*. The flange *e* has notches $i^1$ to $i^5$ formed in its periphery, and the flange *g* has a guideway formed therein, in which is mounted a sliding bolt *j* pressed towards the flange *e* by a spring *k*. A lever *n* engages the bolt *j* to move the latter against the thrust of its spring, and a handle *q* is provided to enable the sleeve *c* to be conveniently rotated by hand. A convenient number of groups of teeth are provided at parts around the flange *e* as shown in Fig. 2, and the members of each group may be variously spaced apart as required. For example, if a multiple spindle drill head having four drill spindles is bolted to the flange *g*, and two notches $i^1$, $i^2$ are provided spaced apart at an angular distance of 45 deg., the four drills in the head can be employed to drill four holes in a piece of work whilst the bolt *j* is in the notch $i^1$. Then, after withdrawing the bolt *j* from the notch $i^1$, the sleeve *c* can be rotated to bring the tooth into the notch $i^2$. When the sleeve is in the position to which it has thus been adjusted, the four drills can be employed to drill four holes accurately in intermediate positions between the four holes first mentioned. Similarly by using a group of notches $i^5$, $i^4$, $i^3$ spaced apart at angles of 30 deg., a four-spindle drill head can be employed to drill 12 holes on the same pitch circle and equally spaced apart. (*Sealed.*)

### MILLING AND SEPARATING MACHINERY.

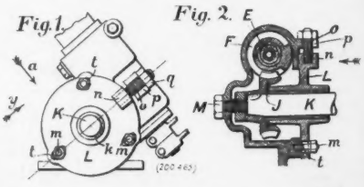
**200,437. Joseph Baker, Sons and Perkins, Limited, London, and W. E. Prescott, London. Grinding or Crushing Machines.** (2 *Figs.*) October 21, 1922.—The invention relates to means for mounting the rollers of grinding or crushing machines. 1 designates a side frame in which are mounted the rollers 2, 3, the upper one, 2, of which is shown as journalled in a block $3a$ mounted to slide vertically in guides 4 in the side frame. This block has upward lugs 5 of triangular form, through which passes a pin 6 on which is mounted between the lugs a screw eye 7, the threaded part of which engages with interior threads in a worm wheel 8, with which meshes a worm 9 carried on the end of a spindle 10 which can be rotated by a hand wheel 11. According to the invention, there is combined with the adjusting gear just described, supplementary gear by which the rollers may be




separated without affecting their primary adjustment. The upper roller 2 is lifted from the lower roller 3 by forming the pin 6 with a portion 12 eccentric to the remainder and forming the screw eye 7 with an enlarged end as shown in Fig. 3, in which is located a sliding block 13 mounted on the eccentric portion 12. The pin is rocked about its axis by an arm 14 to the free end of which is connected a link 15, the end of which is pivoted to a hand lever 16 mounted on a shaft 17. By moving the hand lever 16, for example, to the position shown in dot and dash lines in Fig. 1, the bearing $3a$ and with it the roller 2 is quickly lifted away from the roller 3 by the eccentric portion 12 of the pin sliding the block 13 in the screw eye 7, the latter however remaining vertical and stationary so that the adjustment set by the worm gear 8 and 9 is not disturbed. (*Sealed.*)

### MOTOR ROAD VEHICLES.

**200,465. Sir H. Austin, Bromsgrove. Steering Gear.** (2 *Figs.*) April 20, 1922.—The invention relates to steering gear of motor road vehicles. F is a worm mounted on the foot of the steering sleeve E and meshing with a worm wheel J which is mounted upon a shaft K, which operates to turn the road wheels about their steering axes. The shaft K is arranged to turn in a bush set in a cover L of the casing. This cover is provided with slots *t* directed towards the axis of the worm and through which




pass studs *m*, and with a boss *n* into which is screwed a stud *o* which passes between a pair of jaws *p* of the casing. The stud has a nut *q* screwed upon its end. In order to adjust the worm wheel towards the worm, the nuts of the studs *m* are slackened and the nut *q* given an appropriate turn, thus drawing the cover in the direction of the arrow *y* of Fig. 1; when the correct adjustment is obtained the nuts on the studs *m* are tightened up. The worm wheel is prevented from moving towards the cover L by the bush in which it is mounted, and it is prevented from moving in the opposite direction by a set pin M which is screwed through the wall of the casing and bears at its inner end against the outer end of the shaft K. (*Sealed.*)

THE END OF THE ONE HUNDRED AND SIXTEENTH VOLUME.

NEARLY OUT OF PRINT.

rown 8vo. Cloth. Price 4s. By Post 4s. 6d.

72 pp., with numerous Diagrams.

## TATICALLY INDETERMINATE STRUCTURES AND THE RINCIPLE OF LEAST WORK.

BY

HAROLD MEDWAY MARTIN,

Wh. Sc.

LONDON: Offices of "ENGINEERING," 35 & 36, Bedford Street, Strand, W.C.

FOR SALE.

**Boilers,** Vertical, Loco., Cornish, Launch, Field-tubes, a speciality. Also Air Receivers and Feed-water Heaters.—Apply GRANTHAM BOILER & CRANK Co., Ltd., Grantham.

**Gearing for Power Transmission.** Including Machine Moulded GEAR WHEELS up to 10 feet dia.
SPUR WHEELS (rope or spur drive) up to 28 feet dia.
IRON CASTINGS up to 15 tons each, in Loam, Dry or Green Sand;
ENGINES: "Uniflow," "Corliss" or Drop Valve.
BREAKDOWN Repairs a speciality.
CLAYTON, GOODFELLOW & CO., LTD., Atlas Works, BLACKBURN. 1249

**Two 500 Kw. Generating Sets** 500-550 Volts. 3 Crank enclosed Engines, Dick Kerr, Compound Dynamos, Allen Surface Condensing Plant complete, Baker's Oil Separator. Very low price.
Also DIESEL ENGINES 500 to 1200 HP.
JENNINGS,
West Walls,
Newcastle-on-Tyne. 1701

**For Sale, Two Five Ton** Steam LOCOMOTIVE GRABBING CRANES, by Taylor & Hubbard, jibs about 40 ft. long, to lift 5 tons at 24 ft., 3 tons 30 ft., 2 tons 34 ft., 6'5 gauge, all motions, complete with second friction driven barrel to work grab bucket, or can be used as ordinary cranes.—GEO. COHEN, SONS & CO., 600, Commercial Road, E. 14. C 451

**For Sale, Motor Generator,** by Lancashire Dynamo Co. Ltd., 1920, Comprising, 480 volt, D.C. Motor, coupled to 165 volt, 250 ampere compound interpole Generator, complete with Switchboard.
THE PHŒNIX ELECTRICAL CO., LTD., 17, Oswald Street, Glasgow. C 475

**For Sale, Surface Condensing** PLANT, built by Messrs. The Metropolitan-Vickers Electrical Co., Ltd.
CONDENSER.—Cast iron shell, 3ft. 3in. diameter, 9 ft. 3 in. between plates, solid drawn brass tubes, 19 S.W.G., 1420 square feet surface.
CIRCULATING PUMP.—Rees-Roturbo Centrifugal, 1380 g.p.h., 33 ft. head, at 1440 r.p.m.
AIR PUMP.—Met.-Vickers Leblanc, to deal with 8 lbs. dry air per hour. Vacuum 28·5 at 1440 r.p.m.
RE-ACTION PUMP.—Met.-Vickers Centrifugal, to discharge 23 g.p.m., against a head of 75 ft., including 33 ft. suction at 1440 r.p.m.
MOTOR.—42 B.HP. 3-phase, 60 periods, 440 volts, 1440 r.p.m.
BED PLATE.—Motor, circulating, extraction and air pumps mounted in line.
SPARE PARTS.—(All new and unused).
Motor, with shaft extension either end.
For Leblanc Air Pump. Two sets bearings with oil rings, shaft and keys, collecting cone, wheel rim centre.
For Circulating Pump. Rotor and shaft.
For Condenser. 90 tubes, 30 ferrules.
The plant can be seen at the Collieries of the GRASSMOOR CO., LTD., Chesterfield, to whom enquiries should be addressed. C 410

## CHARLES GRIFFIN & CO., LTD., PUBLISHERS.

*** NOTE.—All prices are net, postage extra.

*JUST PUBLISHED.* In Medium 8vo, Cloth. Very Fully Illustrated. 32s.

**MATERIALS**
AND THEIR APPLICATION TO ENGINEERING DESIGN.
By E. A. ALLCUT, M.Sc. (Eng.), and E. MILLER, M.I.Met., etc.

*JUST PUBLISHED.* FOURTH EDN. Thoroughly Revised. Re-written. Fully Illustrated. 21s

**A TREATISE ON ELECTRO-METALLURGY.**
By W. G. MCMILLAN, F.I.C., and W. R. COOPER, M.A., B.Sc.

*JUST PUBLISHED.* VOL. II. SEVENTH EDITION. Revised and Re-set throughout. Plates and other Illustrations. 32s.

**THE METALLURGY OF STEEL.**
By F. W. HARBORD, C.B.E., and J. W. HALL, M.Inst.C.E.
VOL. II. MECHANICAL TREATMENT. 32s.
(*VOL. I., METALLURGY, will be ready in a few weeks.*)

*JUST PUBLISHED.* SEVENTH EDITION. Fully Illustrated. 21s.

**INTRODUCTION TO THE STUDY OF METALLURGY.**
By Sir W. ROBERTS AUSTEN, K.C.B., and F. W. HARBORD, A.R.S.M.

*JUST PUBLISHED.* In Two Vols., each complete and sold separately.

**THE DESIGN AND CONSTRUCTION OF SHIPS.**
By Sir J. HARVARD BILES, M.Inst.N.A.
VOL. I. CALCULATIONS AND STRENGTH. 3rd Edn. 30s.
VOL. II. STABILITY, RESISTANCE, PROPULSION AND OSCILLATIONS OF SHIPS. 2nd Edn. 30s.

London: CHARLES GRIFFIN & CO., Ltd., 12, Exeter Street, Strand, W.C. 2.

## OXFORD TECHNICAL PUBLICATIONS.

**SANDS AND CRUSHED ROCKS.**
By A. B. SEARLE.
8½ × 5⅝. Cloth. Fully illustrated. In two volumes, together **52s. 6d.** net.

**SITE PLANNING IN PRACTICE.**
By F. LONGSTRETH THOMPSON, B.Sc., Assoc.M.Inst.C.E.
8½ × 5⅝. Cloth. Many plans and photographs. **16s.** net.

**UNIVERSAL SHEET METAL PATTERN CUTTER.**
By W. NEUBECKER.
11½ × 9. Cloth. 68 original drawings. **42s.** net.

**THE MODERN IRONFOUNDRY.**
By JOSEPH G. HORNER, A.M.I.Mech.E.
8½ × 5⅝. Cloth. Fully illustrated. Pp. viii + 256. **15s.** net.

**COLUMNS: Strength and Design of Compression Members.**
By E. H. SALMON, D.Sc. (Eng'g.) London, Assoc.M.Inst.C.E.
8½ × 5⅝. Cloth. Illustrated. **31s. 6d.** net.
*Ready immediately.*

**PRACTICAL ENGINEER MECHANICAL POCKET BOOK AND DIARY, 1924.**
Edited by ERNEST G. BECK, Wh.Ex., Assoc.M.Inst.C.E.
5½ × 3¾. Illustrated. Leather-cloth, **3s.** net; Cloth, **2s. 6d.** net.

**HENRY FROWDE and HODDER & STOUGHTON,**
**1, Bedford Street, Strand, London, W.C. 2.** 1720

ROYAL 8VO. 320 + XVI PAGES. WITH 182 DIAGRAMS and OVER 90 TABLES.

THE
## POWERING OF SHIPS
By J. BERTRAM THOMAS, M.B.E., A.M.Inst.C.E.

This work has been compiled with the idea of collating and condensing much of the available information regarding the resistance of ships and presenting the same in a simple and accessible form. This the author has succeeded in doing; the work of many experimenters of different countries has been examined and the results of their experiments arranged so as to be of ready service to designers.—*Shipbuilding & Shipping Record.*

**Price 25s. net (post free, 25s. 9d. home; 26s. abroad). Cash with Order.**

*Catalogue, giving full Contents of this volume, sent post free on application to the Publishers.* 1719

**SCOTT, GREENWOOD & SON,** 8, Broadway, Ludgate, London, E.C. 4.

Reprinted from "ENGINEERING."

# "THE LAWS OF HEAT TRANSFER."

By H. MEDWAY MARTIN, Wh.Sc., A.C.G.I.

*Crown 4to, 20 pp. - - Paper Cover.*

Price 2/- net.

LONDON:—Offices of "ENGINEERING," 35 & 36, Bedford Street, Strand, W.C. 2.

**Two Sets Compound Jet** Condensing Vertical PUMPING ENGINES. Cylinders 19 in. and 33 in. by 36 in. stroke. 15 r.p.m. Steam Pressure 100 lbs. Double Acting Pumps. Each 300,000 galls. per hour. Maker: Pearn, Manchester, 1899.—Address, C 479, Offices of ENGINEERING.

**National Gas Engine, 50** Brake HP., 150 amp., 220 volt. Dynamo, Siemen's 4 pole d.c. and Switch gear complete, including 60 H.P. motor, A.C. 220. The lot £200.—Apply, ELY'S, Drapers, Wimbledon. C 388

**750 Kw., 500/550 volt., 50** cycle, 3-phase Metropolitan-Vickers HIGH PRESSURE TURBO SET, complete with Condensing Plant and auxiliaries.
Date of construction 1916.
Very reasonable price.
THE PHŒNIX ELECTRICAL CO., LTD., 17, Oswald Street, Glasgow. C 23

**1000 Kw., 3300 volt., 50** cycle, 3-phase B.T.H. TURBO ALTERNATOR, for 200 lbs. steam pressure, complete with Surface Condensing Plant and auxiliaries, new 1914, perfect condition, can be seen under load.
Very low price.
THE PHŒNIX ELECTRICAL CO., LTD., 17, Oswald Street, Glasgow. C 22

**For Sale.—750 Kw., 220 volt.,** D.C. "Parsons-Crompton" GEARED TURBO SET, complete with Jet Condenser and auxiliaries.
Above plant installed new in 1915, and has never given any trouble.
We can supply Surface Type Condensing Plant if required.
Will be sold at a very low figure as it stands at Leeds.
THE PHŒNIX ELECTRICAL CO., LTD., 17, Oswald Street, Glasgow. 832

**Unique Opportunity.**
FOR SALE,
at CONSIDERABLY REDUCED PRICES,
a Number of
**New Electric Portal Harbour Cranes,**
Capacity 3 tons and 1½ tons, at maximum radius 64 ft.
Built to a first-class Colonial Specification.
Ready for IMMEDIATE DELIVERY, including spare parts.
Full particulars on application.
Address, C 212, Offices of ENGINEERING.

**Machinery, Plant, &c.**

No. 60 "HEALD" INTERNAL GRINDING MACHINE, to grind holes 3½ in. dia. and upwards, all-geared head, single pulley drive.

Nearly New, Model S.D. "BECKER" VERTICAL MILLING AND PROFILING MACHINE, single pulley drive, 3½ in. spindle, sleeve 8½ in. diam.

28 in. stroke HEAVY DUTY PILLAR TYPE SHAPING MACHINE, by Columbia M/c. Tool Co., T-slotted table 18 in. by 28 in. by 18 in. deep.

Two New Improved UNIVERSAL SCREWING MACHINES, by Joshua Heap & Co., to take up to 6 in. tubes.

Two very good second-hand three-drum STIRLING WATER TUBE BOILERS, each 1035 sq. ft. heating surface, reinsure at 120 lbs. per sq. in., usual fittings.

FIVE LANCASHIRE BOILERS, 30 ft. by 7 ft. 6 in., now insured at 150 lbs. pressure.

Six VERTICAL COCHRAN BOILERS, 14 ft. 6 in. by 6 ft. 6 in., 150 lbs. working pressure.

One 6-wheel 12 in. LOCOMOTIVE (Manning Wardles), 4 ft. 8½ in. gauge, 140 lbs. pressure.

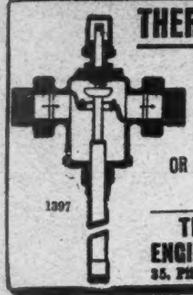
One 4-wheel 14 in. LOCOMOTIVE (Hunslet Engine Co.), 4 ft. 8½ in. gauge, 120 lbs. pressure.

One 12-ton CRANE TYPE STEAM NAVVY, with bucket about 1½ cubic yards capacity; 4 ft. 8½ in. and 5 ft. 3 in. gauges; boiler suitable for 90 lbs.

**Thos. W. Ward, Ltd.,**
ALBION WORKS, SHEFFIELD. 1736

**IT IS WORTH YOUR WHILE TO BUY DIRECT**
Reliance Anti-corrosive Lubricants for Commercial and Private Motor-cars, Engine, Cylinder, and Machinery Oils, Axle Oils, Gas Engine and Oil Engine Oils, Ice Machine Oils, Double Filtered Oil for Ford Cars, Soluble Oil for Screwing and Boring Purposes. Solidified Oils, Astral Disinfectant.—From the
**RELIANCE LUBRICATING OIL CO., LTD.,**
19 & 20, Water Lane, Great Tower Street, London, E.C. 3.
(Agents Wanted.) 1268

We are manufacturers of all kinds of labels and 1497
**NAME PLATES**
and have facilities for undertaking all classes of engraving work. If you are requiring anything involving lettering on metal, celluloid, etc., etc., write to:—
**THE STIMUR MFG. CO.,** Macdowall St., Paisley.



**THERMOSTATS**

— for —

Controlling Steam to CALORIFIERS, OR HOT WATER TANKS.

1397

**THE HORNE ENGINEERING CO.,**
35, Pitt Street, Glasgow.

**THE MITCHELL CONVEYOR AND TRANSPORTER CO., LTD.,**
*Contracting Engineers.*

HANDLING MITCHELL PLANTS

Designers and Builders of all classes of HANDLING MACHINERY. 1713
Atlantic House, 45-50, Holborn Viaduct, London, E.C. 1.
Grams: Micontrace, Cent, London. Tel.: Holborn 2522.

*Electric*

**CRANES & CAPSTANS**
AND
**DYNAMOS & MOTORS**
*For all purposes.*

Royce Limited,
Trafford Park, Manchester.

Telegrams: Royces Manchester. 1309
Telephones: 690, 691, 692 Trafford Park.

**BEST QUALITY.**
**PURIFIED COKE BREEZE**
AT
**EXCEPTIONALLY LOW PRICES.**

Requiries Promptly Attended To.

**BRENTNALL & CLELAND,**
216, Corporation St., BIRMINGHAM.
TELEPHONE: CENTRAL 1722. 1667
London, Birmingham, Manchester, and elsewhere.

**GOVERNORS**

1639

**PICKERING TYPE.**

**IMMEDIATE DELIVERY.**

HENRY ROLLINS BRAKE & SONS, Ltd., STOCKPORT.

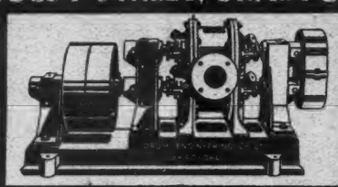
**MINE VENTILATION**
*WITHOUT*
**FIRE RISK.** 1686

The TYPHOON TURBINE BLOWER, driven by compressed air, requires neither belts nor electric motor. Easily installed.
*Prices and Particulars from Makers—*

MURRAY, McVINNIE & CO., LTD.,
MAVISBANK, GLASGOW.

**The DRUM ENGINEERING Co. Ltd.**
28, HUMBOLDT STREET, BRADFORD, YORKS.

FOR:-
WATER
OILS
SEMI-FLUIDS
TAR
ACIDS.



DESIGNED TO SUIT ANY METHOD OF DRIVE.

*Telegrams* "DRUM" *Bradford.*

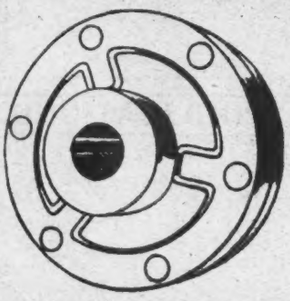
"DRUM" PUMP

NO VALVES

POSITIVE ACTION

*Write for Catalogue* № 90

**FLEXIBLE REVERSIBLE INSULATING COUPLING.**
THE "SYKES" PATENT. (Patent No. 106062).



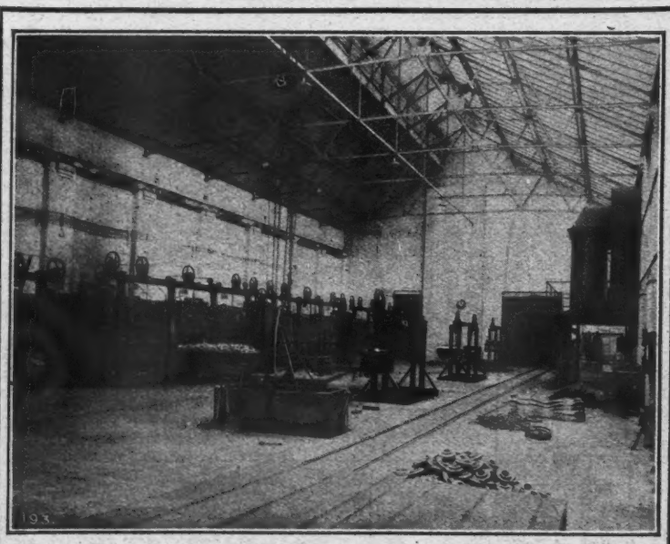
For coupling Motors, Dynamos, Printing Machinery, Steel Rolling Mills, and all kinds of Machines and shafts. Reduces breakages due to vibration and shock. Reduces friction on shafts wearing out of line.

Allows Longitudinal Expansion. Will run in either direction. Renewal of Buffers effected without dismantling of shafts or machines.

Parts are ELECTRICALLY Insulated. Has no springs. Large range of flexibility, with full or partial load.

**SIMPLE IN DESIGN.**

*SOLE MAKERS* **NEWTON, BEAN & MITCHELL,**
**DUDLEY HILL, BRADFORD.**
Telegrams: ADROIT, DUDLEY HILL. 862 'Phone: 25 (2 lines) Dudley Hill.



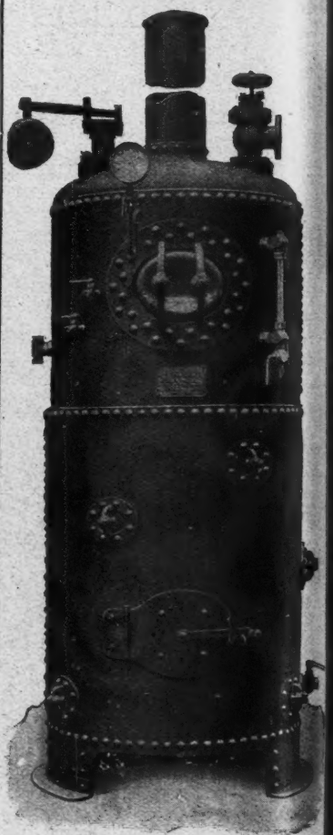
Complete Heat Treatment Plant installed by us in works of well-known Drop Stamping Co.

**FURNACES**, to operate on any fuel.
**GAS PRODUCER PLANT,**
**CHARGING MACHINES**, hand or power.
**QUENCHING TANKS and APPLIANCES.**
**OIL COOLERS**, patent air film type.

**THE INCANDESCENT HEAT CO., LTD.,**
Cornwall Road, Smethwick, Birmingham.
'Phone: Smethwick 275 & 276. 'Grams: "Repeat," Smethwick. 1332

If you want the Best Gauge Glasses ORDER
**'Bishop's Adamant'**
TRADE MARK
**Gauge Glasses**
MADE IN ENGLAND.
YOU CANNOT BUY BETTER.
REFLEX GLASSES
supplied in hardened glass.
*Samples, Lists & Prices free on request.*
S. & C. BISHOP & CO., LTD.
St. Helens, Lancashire. 1661

**ABBOTT & CO.**
(NEWARK), LTD.,
*NEWARK-ON-TRENT, ENGLAND.*
MAKERS OF EVERY TYPE OF
**HIGH-PRESSURE STEAM**
**BOILERS**
From 1 to 200 I.HP., 50 lb. to 300 lb. Working Pressure.



FLANGED and WELDED WORK of every description. MOTOR VAN BOILERS. HYDRO CASINGS. REPAIR FIRE-BOXES. EVAPORATOR SHELLS. AIR RECEIVERS. DECREASING PLANTS. VULCANISING PANS, &c.

1943

Contractors to the Admiralty, War Office, India Office, Board of Customs, Crown Agents, &c., &c.

Telegraphic Address: - - "ABBOTT, NEWARK."
Telephone: No. 84. A B C Code 4th and 5th Editions.

1923.

asses

ıant'

RK

ges

ETTER.

SSES

ass.

request.

, LTD.

re. 1661

CO.

TD.,

GLAND.

OF

TEAM

RS

300 lb.

of every

OILERS.

E-BOXES.

CEIVERS.

ANISING

ar Office,

vn Agents.

THWARK."

h Edition.

# INDEX TO ADVERTISEMENTS.


| | PAGE |
|---|---|
| Abbott & Co. (Newark) Ltd. | 4 |
| Adson & Co., Ltd. | 82 |
| Alexander, E. F., & Sons | 2 |
| Alexander, Herbert, & Co. | 88 |
| Allen-Liversidge, Ltd. | 76 |
| Allen, W. H., Sons & Co. Ltd. | 47 |
| Alley & MacLellan, Ltd. | 1 |
| American Loco. Sales Corpn. | 6 |
| Amsler, A. J., & Co. | 22 |
| Andrews & Beaumont | 1 |
| Angus, Geo., & Co., Ltd. | 3 |
| Archdale, Jas., & Co., Ltd. | 41 |
| Armstrong, Stevens & Son | 67 |
| Arnold, Wm., & Co. | 68 |
| Asquith, Sir W., & Co., Ltd. | 81 |
| Ashmore, Benson, Pease & Co., Ltd. | 17 |
| Asquith, Wm. (1920), Ltd. | 49 |
| Assoc. British Machine Tool Makers, Ltd. | 40 & 41 |
| Assoc. Engineering Co. (1913), Ltd. | 64 |
| Atlas Gears (Leeds), Ltd. | 1 |
| Atlas Machinery Co., Ltd. | 75 |
| Avery, W. & T., Ltd. | 83 |
| Aveling & Porter, Ltd. | 1 |
| Bagnall, W. G., Ltd. | 86 & 94 |
| Baldwin & Co., Ltd. | 91 |
| Barnard, H. B., & Sons | 90 |
| Bayliss, Jones & Bayliss, Ltd. | 22 & 87 |
| Beamore, Wm., & Co., Ltd. | 34 |
| Bedford Engineering Co. | 9 |
| Bedoe, A. | 88 |
| Bellam Pigg & Rubber Co. | 70 |
| Bellamy, John, Ltd. | 16 |
| Bellis & Morcom, Ltd. | 53 |
| Bennis, Ed., & Co., Ltd. | 91 |
| Bergius Company, Ltd. | 92 |
| Berry, Francis, & Sons | 80 |
| Berry, Henry, & Co., Ltd. | 45 |
| Bertrams, Ltd. | 88 |
| Bigwood, J., & Son, Ltd. | 91 |
| Billington & Newton, Ltd. | 46 |
| Binn, R. C. & W., Co., Ltd. | 23 |
| Bishop, S. & C., & Co., Ltd. | 4 |
| Blake, John, Ltd. | 92 |
| Bodley Bros. & Co., Ltd. | 93 |
| Booth, Jas., & Bros., Ltd. | 91 |
| Bolton & Paul, Ltd. | 89 |
| Boring Eng. Works, Ltd. | 77 |
| Braby, Fred., & Co., Ltd. | 9 |
| Bradley & Craven, Ltd. | 6 |
| Brentnall & Cleland | 4 |
| Brett's Patent Lifter Co. Ltd. | 1 |
| British Arca Regulators, Ltd. | 88 |
| British Bock Bearings, Ltd. | 13 |
| British Niclausse Boiler Co. | 89 |
| British Ropeway Eng. Co. | 93 |
| British Steam Specialties | 48 |
| British Thomson-Houston Co., Ltd. | 44 |
| Broadbent, T., & Sons, Ltd. | 30 |
| Brookes & Adams, Ltd. | 8 |
| Broom & Wade, Ltd. | 65 |
| Brotherhood, Peter, Ltd. | 1 |
| Broughton Copper Co., Ltd. | 90 |
| Brown, David, & Sons (Huddersfield), Ltd. | 1 & 31 |
| Brown, W. B., & Co. (Bankhall), Ltd. | 90 |
| Brundrit, Joseph | 26 |
| Buck & Hickman, Ltd. | 72 |
| Buckton, Joshua, & Co., Ltd. | 13 |
| Budenberg Gauge Co., Ltd. | 21 |
| Buhring's Patent Water Purifying Co. | 89 |
| Bull's Metal & Melloid Co. | 83 |
| Butler, Samuel, & Co., Ltd. | 89 |
| Butterley Co., Ltd. | 77 |
| Butterworth, Bros., Ltd. | 1 |
| Caird & Rayner | 93 |
| Cambridge & Paul Instrument Co., Ltd. | 46 |
| Cammell, Laird & Co., Ltd. | 67 |
| Campbell Gas Engine Co. | 57 |
| Campbells & Hunter, Ltd. | 1 |
| Carels, Diesel & Steam Engines (London), Ltd. | 1 |
| Caxton Wood Turnery Co. | 58 |
| Celite Products Corporation | 1 |
| Chaplin, Alex., & Co., Ltd. | 64 |
| Chatteris Engineering Co. Ltd. | 16 |
| Chesterfield Tube Co., Ltd. | 15 |
| Christiani & Nielsen | 91 |
| Citroen Gear Co., Ltd. | 9 |
| Clarke, Chapman & Co., Ltd. | 62 |
| Clayton, Goodfellow & Co. Ltd. | 3 |
| Clayton, Son & Co., Ltd. | 22 |
| Cleveland Bridge & Eng. Co. | 93 |
| Clifton & Baird, Ltd. | 58 |
| Clyde Structural Iron Co. | 93 |
| Cochran & Co. (A.), Ltd. | 1 & 17 |
| Cochrane, John (Barrhead), Ltd. | 86 |
| Cockburn, A., & Co. | 68 |
| Cockburns, Ltd. | 15 |
| Coles, Henry J., Ltd. | 88 |
| Consolidated Brake & Eng. Co. Ltd. | 39 |
| Constructional Engineering Co., Ltd. | 88 |
| Cowans, Sheldon & Co., Ltd. | 28 |
| Craig, A. F., & Co. | 88 |
| Crofts (Engineers), Ltd. | 5 |
| Crosby Valve & Eng. Co. Ltd. | 85 |
| Crowther, Henry, & Co. | 83 |
| Daiglish, A. & W. | 68 |
| Dallow Lambert & Co., Ltd. | 69 |
| Danks, H. & T. (Netherton) Ltd. | 88 |
| Darlington Forge, Ld. (The) | 89 |
| Davidson & Co., Ltd. | 63 |
| Davis, E. J. | 1 |
| Davis & Primrose, Ltd. | 86 |
| Davy Brothers, Ltd. | 49 |
| Dawson & Downie, Ld. | 74 |
| Day, Summers & Co., Ltd. | 60 |
| De Laval Chadburn Co., Ltd. | 73 |
| Dempster, Robt., & Sons, Ltd. | 90 |
| Dempster, Moore & Co., Ltd. | 91 |
| Dennystown Forge Co. | 12 |
| Drum Engineering Co., Ltd. | 4 |
| Drysdale & Co., Ltd. | 3 |
| East Ferry Road Engineering Works Co., Ltd. | 15 |
| Edmeston, A., & Sons, Ltd. | 14 |
| Electric Construction Co., Ltd. | 83 |
| Electro-Mechanical Brake Co., Ltd. | 46 |
| Elliot, Geo., & Co., Ltd. | 3 |
| Ellison, George | 53 |
| Ellison, W. T., & Co., Ltd. | 93 |
| Empire Engineering Co. (Manchester), Ltd. | 88 |
| English Electric Co., Ltd. | 48 |
| Entwisle & Gass, Ltd. | 89 |
| Escher, Wyss & Co. | 86 |
| Etna Engineering Co. | 6 |
| Evans, Joseph, & Sons, Ld. | 51 |
| Everitt, Allen & Sons, Ltd. | 73 |
| Farrar Boilerworks, Ltd. | 72 |
| Fawcett, Preston & Co., Ltd. | 20 |
| Ferguson Bros. (Port Glasgow) Ltd. | 89 |
| Ferro-Arc Welding Co., Ltd. | 85 |
| F.I.A.T. | 51 |
| Firth, Thos., & Sons, Ld. | 37 & 48 |
| Fleming & Ferguson, Ltd. | 7 |
| Foster Bros., Ltd. | 87 |
| Fraser & Chalmers Eng. Works | 55 |
| Frowde, Hy., & Hodder & Stoughton | 3 |
| Fuller, Horsey, Sons & Cassell | 1 |
| Galloways, Ltd. | 63 |
| Geipel, Wm., & Co. | 91 |
| General Electric Co., Ltd. | 11 |
| Gibbons Bros., Ltd. | 89 |
| Gilkes, G., & Co., Ltd. | 18 |
| Glasgow Rly. Eng. Co., Ltd. | 1 |
| Glenfield & Kennedy, Ltd. | 63 |
| Globe Pneumatic Eng. Co. Ltd. | 31 |
| Grafton & Co. | 92 |
| Grantham Boiler & Crank Co. | 3 |
| Grieve, John, & Co. | 70 |
| Griffin, Chas., & Co., Ltd. | 3 |
| Guest & Chrimes, Ltd. | 70 |
| Gunther, W., & Sons | 69 |
| Haighs (Oldham), Ltd. | 56 |
| Halesowen Steel Co., Ltd. | 75 |
| Hall, J. & E., Ltd. | 89 |
| Hall, J. P., & Co., Ltd. | 21 |
| Hall, J. P., & Sons, Ltd. | 93 |
| Hampton & Beebee, Ltd. | 19 |
| Hainworthy Eng. Co., Ltd. | 89 |
| Hands, John, & Sons, Ltd. | 76 |
| Hart, Thos., Ltd. | 21 |
| Harvey, G. A., & Co. (Lond.), Ltd. | 13 |
| Harvey, G. & A., Ltd. | 19 |
| Hasiam Foundry & Eng. Co., Ltd. | 81 |
| Hawthorn, R. & W., Leslie & Co., Ltd. | 1 & 79 |
| Head, Wrightson & Co., Ltd. | 1 & 55 |
| Henderson & Glass | 22 |
| Hendry, James, Ltd. | 71 |
| Herbert, Alfred, Ltd. | 24 |
| Heywood, S. H., & Co., Ltd. | 1 |
| Hick, Hargreaves & Co., Ltd. | 73 |
| Higginbottom & Mannock | 71 |
| Highfield Gear Cutting Co. | 1 |
| Hoffmann Mfg. Co., Ltd. | 29 |
| Hollingdrake, Heary & Sons | 4 |
| Holman Bros., Ltd. | 87 |
| Hopkinson, J., & Co., Ltd. | 14 |
| Horne Engineering Co. | 4 |
| Horseley Bridge & Eng. Co., Ltd. | 32 |
| Hudson, Thos., Ltd. | 91 |
| Hudswell, Clarke & Co., Ltd. | 78 |
| Hughes & Lancaster, Ltd. | 93 |
| Humpage, Thompson and Hardy | 69 |
| Humphreys & Glasgow, Ltd. | 47 |
| Hunslet Engine Co., Ltd. | 79 |
| Hunt, Thomas, & Sons | 1 |
| Hurst, Nelson & Co., Ltd. | 1 |
| Ignanite Electric Co., Ltd. | 90 |
| Incandescent Heat Co., Ltd. | 4 |
| International Elestrolytic Co., Ltd. | 70 |
| Ironite Co., Ltd. | 10 |
| Isler, C., & Co., Ltd. | 79 |
| Jack, Alex., & Co., Ltd. | 86 |
| Jackson, C. & Co. | 68 |
| Jenkins Bros., Ltd. | 75 |
| Jennings, R. J. | 3 |
| Johnson & Phillips, Ltd. | 85 |
| Johnson, W., & Sons (Leeds), Ltd. | 82 |
| Jones & Lamson Mach. Co. | 60 |
| Kaye, Joseph, & Sons, Ltd. | 89 |
| Kent, Geo., Ltd. | 63 |
| Kermodes, Ltd. | 1 |
| Kerr, Stuart | 93 |
| Kincaid, J. G., & Co., Ltd. | 85 |
| Kings Patent Agency | 1 |
| Kirkaldy, John, Ltd. | 1 & 2 |
| Kirkstall Forge Co., Ltd. | 84 |
| Kitchen & Wade | 74 |
| Lancashire Dynamo and Motor Co., Ltd. | 66 |
| Lancaster & Tonge, Ltd. | 12 |
| Lang, John, & Sons, Ltd. | 41 |
| Lea Recorder Co., Ltd. | 8 |
| Leathers Co. (Alt.), Ltd. | 90 |
| Le Bas, Edward, & Co. | 68 |
| Lees, T. & R., Ltd. | 93 |
| Lidgerwood Ltd. | 92 |
| Lion Engineering Co., Ld. | 83 |
| Llewellans Machine Co. | 11 |
| Lloyd, F. H., & Co., Ltd. | 84 |
| Lockwood & Carlisle, Ltd. | 82 |
| Lumbys, Ltd. | 69 |
| Lumsden Machine Co., Ltd. | 14 |
| Lysaght, John, Ltd. | 98 |
| MacFarlane Eng. Co. Ltd. | 54 |
| Mackies (1921), Ltd. | 93 |
| Macielian, P. & W., Ltd. | 1 |
| Maiden & Co., Ltd. | 54 |
| Manchester Steam Users Association | 2 |
| Manning, Wardle & Co., Ltd. | 1 |
| Marple & Gillott, Ltd. | 28 |
| Marshall, Fleming & Co., Ltd. | 91 |
| Massey, H. & S., Ltd. | 14 |
| Mavor & Coulson, Ltd. | 88 |
| Maxwell & Fage | 88 |
| Mechans, Ltd. | 93 |
| Meldrums, Ltd. | 47 |
| Michell Bearings, Ltd. | 88 |
| Midland Bright Drawn Steel and Engineering Co. | 94 |
| Mirrlees Watson Co., Ltd. | 29 |
| Mitchell Conveyor and Transporter Co., Ltd. | 4 |
| Morris, Herbert, Ltd. | 36 |
| Morton, Francis & Co., Ltd. | 82 |
| Motherwell Bridge Co., Ltd. | 86 |
| Mountford, Fredk. (B'ham.) Ltd. | 69 |
| Mumford, A. G., Ltd. | 1 & 18 |
| Murray, McVinnes & Co., Ld. | 4 |
| Musgraves Bros. | 90 |
| Musgrave, John, & Sons, Ld. | 23 |
| Myerson, F. T. | 22 |
| Newton, Bean & Mitchell | 4 |
| Newton, Chambers & Co., Ltd. | 80 |
| Noble & Lund, Ltd. | 80 |
| North British Loco. Co., Ltd. | 78 |
| Nuttall, W. P., Ltd. | 13 |
| Oakey, J., & Sons, Ltd. | 92 |
| Osborn, S., & Co., Ltd. | 27 |
| Parkinson, F. & A., Ltd. | 10 |
| Parkinson, J., & Son | 40 |
| Parsons Motor Co., Ltd. | 7 |
| Pat. Lightning Crusher Co. | 87 |
| Paterson Eng. Co., Ltd. | 91 |
| Paul, Matthew & Co., Ltd. | 1 |
| Pearn, Frank, & Co. Ltd. | 26 |
| Peckett & Sons, Ltd. | 79 |
| Pegler Bros. & Co. (Glas.) Ltd. | 69 |
| Petters, Ltd. | 11 |
| Phillips, Trevor W. | 2 |
| Pickering, R. Y., & Co., Ld. | 1 |
| Piggott, Thos., & Co., Ltd. | 1 |
| Platt, Samuel, Ltd. | 46 |
| Plenty & Son, Ltd. | 19 |
| Positive Lock Washer Co. | 92 |
| Pott, Cassels & Williamson | 1 |
| Pratchitt Bros. | 20 |
| Premier Cooler & Eng. Co., Ltd. | 73 |
| Premier Gas Engine Co., Ld. | 52 |
| Proctor, Jas., Ltd. | 16 |
| Pulsometer Eng. Co., Ltd. | 94 |
| Ransome, A., & Co., Ltd. | 94 |
| Ransome Machinery Co. (1920), Ltd. | 66 |
| Rapid Magnetting Mch. Co. | 93 |
| Redman, C., & Sons, Ltd. | 84 |
| Rees Roturbo Mfg. Co., Ltd. | 18 |
| Reid Gear Co. | 79 |
| Reliance Lubricating Oil Co. | 3 |
| Renold, Hans, Ltd. | 38 |
| Reyrolle, A., & Co., Ltd. | 15 |
| Richardsons, Westgarth and Co., Ltd. | 88 |
| Ritchie Atlas Engineering Co. | 7 |
| Robinson, Thos., & Son, Ltd. | 33 |
| Roe & Harrison, Ltd. | 70 |
| Roots, James D. | 1 |
| Rosser & Russell, Ltd. | 1 |
| Rotherham Forge & Rolling Mill Co., Ltd. | 23 |
| Royce, Ltd. | 4 |
| Royles Ltd. | 1 & 39 |
| Russell, G., & Co., Ltd. | 1 & 94 |
| Russell, John, & Co., Ltd. | 92 |
| Sankey, Jos., & Sons, Ltd. | 9 |
| Scott, Greenwood & Co. | 3 |
| Scottish Stamping & Eng. Co. Ltd. | 23 |
| Scottish Tube Co., Ltd. | 1 |
| Seagers Ltd. | 18 |
| Sedgwick & Co. | 91 |
| Serck Radiators, Ltd. | 10 |
| Semet-Solvay & Plette Coke Oven Co., Ltd. | 17 |
| Shanks, Thomas, & Co. Ltd. | 40 |
| Shaw, W., & Co. Ltd. | 22 |
| Shore, Thos., & Sons, Ltd. | 21 |
| Siebe, Gormas, & Co., Ltd. | 92 |
| Simon-Carves, Ltd. | 18 |
| Smethwick Stamping Co., Ltd. | 82 |
| Smidth, F. L., & Co., Ltd. | 24 |
| Smith, E. J., & Co. (Metals) Ltd. | 86 |
| Smith, T., & Sons (Rodley), Ltd. | 93 |
| Smulders, A. F. | 74 |
| Somers, Walter, Ltd. | 1 |
| Spencer-Bonecourt, Ltd. | 1 & 71 |
| Spencer, John, Ltd. | 89 |
| Standard & Oswald Stott (Engineers) Ltd. | 78 |
| Standard Piston Ring and Eng. Co., Ltd. | 71 |
| Steel Barrel Co., Ltd. | 61 |
| Steel Co. of Scotland, Ltd. | 12 |
| Steel Construction Co., Ltd. | 59 |
| Steel Pipe Co., Ltd. | 59 |
| Stephenson, Robert, & Co. | 91 |
| Sterne, L., & Co., Ltd. | 21 |
| Steven, A. & P., Ltd. | 68 |
| Stewart, Duncan, & Co., Ltd. | 66 |
| Stewarts & Lloyds, Ltd. | 1 & 56 |
| Stimur Manufacturing Co. | 3 |
| Stone, J. B., & Co., Ltd. | 92 |
| Storr & Evans | 1 |
| Stothert & Pitt, Ltd. | 38 |
| Sturtevant Eng. Co., Ltd. | 19 |
| Submersible Motors, Ltd. | 71 |
| Sudron, Thos., & Co., Ltd. | 83 |
| Summerson, T., & Sons, Ltd. | 1 |
| Superchester Units, Ltd. | 85 |
| Swift, George, & Sons, Ltd. | 30 |
| Taylor & Challen, Ltd. | 1 |
| Telephone Manuf'g Co., Ld. | 69 |
| Thomas & Bishop, Ltd. | 90 |
| Thompson Bros. (Bilston), Ltd. | 76 |
| Thompson, John (Wigan), Ltd. | 86 |
| Thornycroft, John I., & Co., Ltd. | 25 |
| Tinker, Shenton & Co., Ltd. | 12 |
| Tomey, J., & Sons, Ltd. | 83 |
| Trier Bros., Ltd. | 93 |
| Tubes, Ltd. | 57 |
| Tullis, D. & J., Ltd. | 86 |
| Turbine Furnace Co., Ltd. | 88 |
| Underfeed Stoker Co., Ltd. | 47 |
| Universal Valve & Chemical Accessories Co. | 70 |
| Vacuum Brake Co. | 89 |
| Valor Co., Ltd. | 76 |
| Variable Speed Gear, Ltd. | 57 |
| Vickers Limited | 42 & 43 |
| Vickers-Petters, Ltd. | 11 |
| Vosper & Co., Ltd. | 1 |
| Wallwork, Henry, & Co., Ltd. | 93 |
| Ward, Thos. W., Ltd. | 3 & 27 |
| Weir, G. & J., Ltd. | 35 |
| Wells, A. C., & Co. | 93 |
| Werf Conrad | 1 |
| West, H. J., & Co., Ltd. | 83 |
| West Hydraulic Eng'r. Co., | 77 |
| Westinghouse Brake and Saxby Signal Co., Ltd. | 75 |
| Westminster Tool & Electric Co., Ltd. | 12 |
| Wheatley Kirk, Price and Co. | 2 |
| White, Ed., & Sons | 86 |
| Whitecross Co., Ltd. | 17 |
| Wigglesworth, F., & Co., Ltd. | 90 |
| Wild, M. B., & Co., Ltd. | 88 |
| Wiley, James, & Sons, Ltd. | 69 |
| Willcox, W. H., & Co., Ld. | 5 |
| Williams, J. H., & Co. | 87 |
| Wilson Boilermakers, Ltd. | 9 |
| Wilson, J. H., & Co., Ld. | 77 |
| Woodite Company | 92 |
| Worthington-Simpson, Ld. | 74 |
| Wright's Forge & Eng. Co. | 93 |
| Wright, John & Edwin, Ltd. | 86 |
| Yarrow & Co., Ltd. | 1 |
| Yorkshire Engine Co., Ltd. | 79 |
| Youngs | 89 |


"ENGINEERING" CLASSIFIED DIRECTORY OF CURRENT ADVERTISEMENTS.

The SEPTEMBER EDITION, in compact book form is NOW READY, and may be obtained gratis from the Publisher. It also contains the Telegraphic Addresses, Codes and Telephone Numbers of our Advertisers, and Glossaries for the use of Foreign Buyers in French, Italian, Spanish, and German.


LUBRICATION

Willcox's

"FISKE" PURE PETROLEUM BASE GREASES

High grade and thoroughly reliable. The result of over a half-century's experience in grease production.
100% lubricant, no waste, no filling matter.
Great economy over low priced "filled" greases.

W. H. WILLCOX & CO., Ltd.,
32-38, Southwark Street, LONDON, S.E.1.

THE "WILLCOX-FISKE" RANGE OF GREASES includes:

CUP GREASES, for Bearings, Plummer Blocks, Cross Heads, &c.
GRAPHITE GREASES.
PHŒNIX FIBRE GREASES, for Machinery where high operating temperatures exist.
TALLOW COMPOUND.
BLOCK GREASE, for hot bearings where temperature is above 200° F.
CRYSTAL LUBRICANTS, of a non-staining character, for lubrication of Textile Machinery.
DARK GEAR-CASE LUBRICANT, for Gear-boxes, &c.
GEAR COATING, for Gears and Pinions of all classes of Machinery.
ROLLER & BALL BEARING GREASE.
AXLE GREASES.
TUNNEL BEARING GREASE, for lubricating bearings in tunnels of Steam Ships.
AUTOMOBILE GEAR & CHASSIS GREASES.

*Samples and quotations submitted upon receipt of application.* 1534

GEORGE ELLIOT & CO., LTD.,
MAKERS OF ALL DESCRIPTIONS OF WIRE ROPES.
MANUFACTURERS OF Od 9100
LANG'S LAY WIRE ROPES
Office: 16, GREAT GEORGE STREET, WESTMINSTER, LONDON.

LANG'S LAY WIRE ROPE WHEN NEW.

LANG'S LAY WIRE ROPE WHEN WORN.

Crofts ENGINEERS LTD.

POWER TRANSMISSION APPLIANCES

We Design, Manufacture and Erect Complete Transmission Installations. Our experience is at your service.

*Catalogues on Request.*

We shall be pleased to quote for your requirements.

SHAFTING, BEARINGS, COUPLINGS, FIXINGS, BELT & ROPE PULLEYS, FRICTION CLUTCHES, VARIABLE SPEED GEARS, MACHINE CUT GEARING, Etc., Etc.

Worm and Spur Reduction Gears a Speciality.

CROFTS LTD ENGINEERS

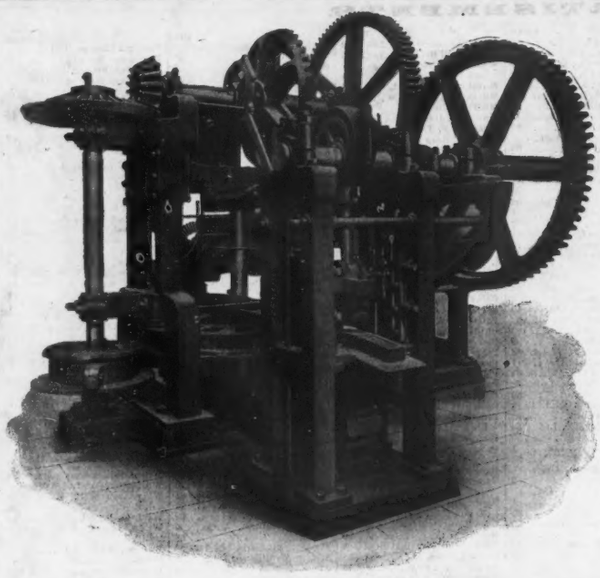
BRADFORD, ENG:

LONDON OFFICE - - 46, CANNON ST., E.C.4.
MANCHESTER OFFICE - - 42, DEANSGATE.

Telegrams: "Crofters, Bradford."

Telephone: 4901 (4 lines).

4363



# BRADLEY & CRAVEN, LTD.

ESTABLISHED 1843. WAKEFIELD.

PIONEERS OF **STIFF PLASTIC BRICK MAKING MACHINERY.**

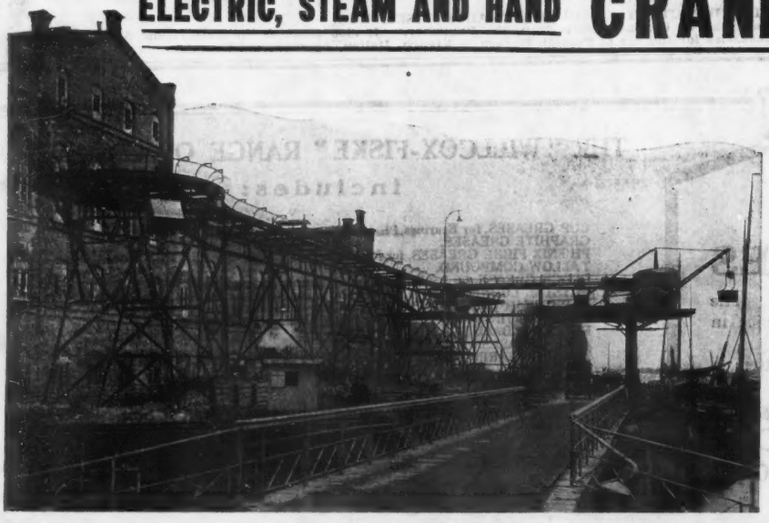
BRICKS PRODUCED BY OUR LATEST IMPROVED MACHINES ARE OF UNEQUALLED STRENGTH AND FINISH. READY FOR IMMEDIATE DELIVERY TO KILN.

No. 1 "STIFF-PLASTIC" BRICK-MAKING MACHINE, Output 1000/1200 per hour.

We also build a larger Machine (No. 2 size) for 1800/2000 per hour. 06385

HIGHEST OUTPUT——HIGHEST QUALITY.

## ELECTRIC, STEAM AND HAND CRANES FOR EVERY SERVICE.



OVERHEAD TRAVELLING CRANES for loads up to 125 tons.

HIGH SPEED JIB & TITAN CRANES for Docks, Harbours, Shipyards, etc.

TELPHER LINES & TRANSPORTERS for Cab or Remote Control.

ELECTRIC WINDING ENGINES for Collieries, Mines, etc.

**STORK - HIJSCH**

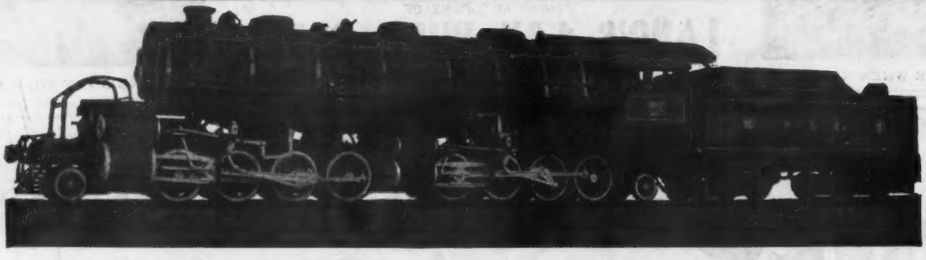
HENGELO (HOLLAND).

LONDON OFFICE:

**THE ETNA ENGINEERING CO.,**

Effingham House, ARUNDEL STREET, W.C. 2.

Telegrams: "ETNASTOK ESTRAND." Telephone: CENTRAL 1288. 1609



BUILT FOR THE PEKING SUIYUAN RAILWAY, CHINA.

Total Weight of Engine, 446,000 pounds; Weight on Driving Wheels, 388,500 pounds; Diameter of Driving Wheels, 50 inches; Boiler Pressure, 220 pounds; Cylinders, 24 and 38 by 28 inches; Maximum Tractive Power, Compound, 92,500 pounds; Maximum Tractive Power, Simple, 110,000 pounds.

TELEGRAPHIC ADDRESSES

Locomotive, New York City. Lococorp, Paris, France.
Sivad, London, England. Thaine, Lourenco Marques, Port. East Africa.

# AMERICAN LOCOMOTIVE SALES CORPORATION.

NEW YORK CITY. 1597

**BUCKET DREDGERS**
Hopper and Barge Loading.
Bow and Stern Well.

**FLOATING CRANES**

**ROCK BREAKING PLANT**
For Rock Cutting Under Water Without Explosives.

**HOPPER BARGES, TUGS, AND FERRY STEAMERS**

*Established 1878.*

TO THE LARGEST DIMENSIONS & CAPABILITIES

**PATENT CUTTER HOPPER DREDGERS**

Od1203

**SUCTION PUMP DREDGERS**
To Discharge into their own Hoppers, into Barges, or Ashore through Floating Pipes.

**TRAILING SUCTION HOPPER DREDGERS**

New Buckets, Links, Pins, Gearing, &c., supplied for existing Dredgers.

*London Office:*
**91, Victoria St., Westminster, S.W. 1.**
TELEGRAMS: "DREDGERIA, SOWEST, LONDON."
TELEPHONE NO.: VICTORIA 6894.

**FLEMING & FERGUSON, Ltd., PAISLEY, near GLASGOW.**
Telegrams: - - - - - "PHŒNIX, PAISLEY." Telephone No.: - - - - - PAISLEY 2648.

**TRANSPORTATION PLANT.**

Form 6152.

Built in Lengths 15 to 39 ft.

Elevating 8 to 20 ft.

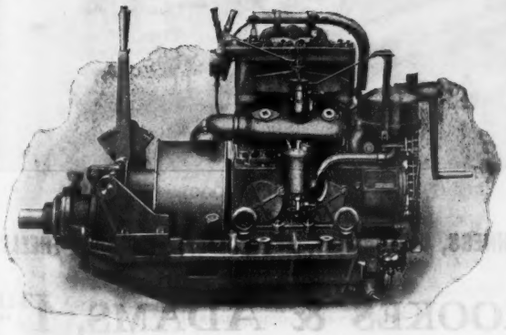
Capacity to 100 Tons per hour.

Fixed and Portable Conveyors with Metallic Belt for Abrasive Materials.

1544

**THE RITCHIE-ATLAS ENGINEERING CO., ATLAS WORKS, TEMPLE, GLASGOW.**

**PARSONS ENGINES**



14 H.P. PARSONS MARINE-SET WITH BUILT-IN REVERSE GEAR.

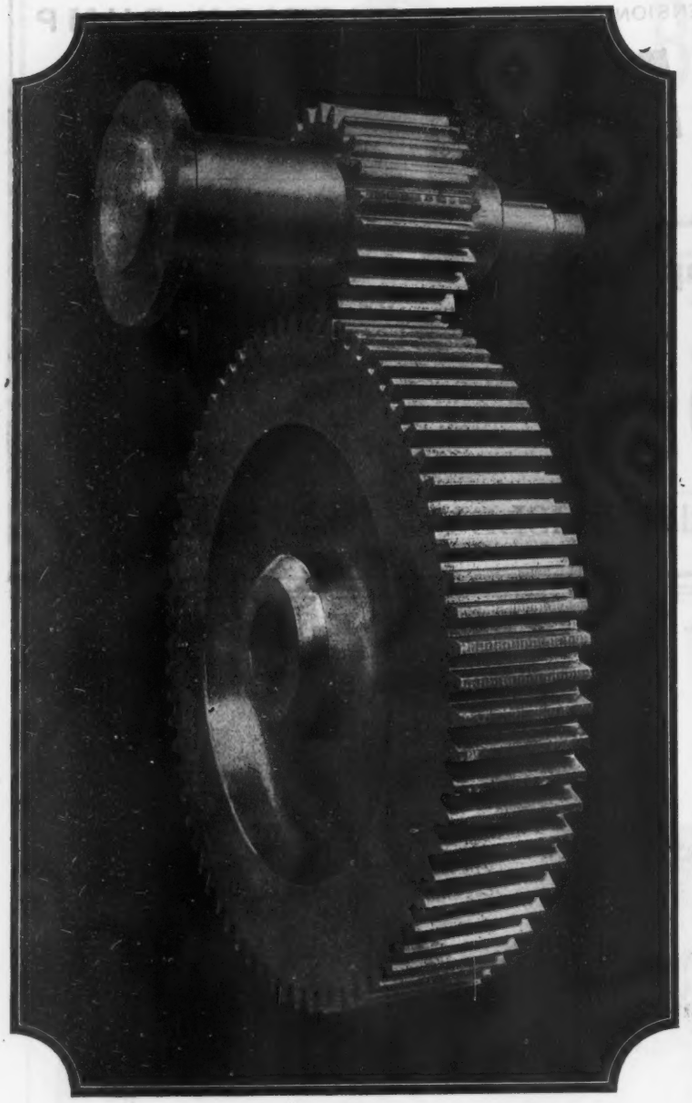
PETROL AND PARAFFIN
PROPELLING MACHINERY
FOR
**MOTOR LIFEBOATS**
AND ALL TYPES OF
COMMERCIAL CRAFT.

FULL PARTICULARS ON APPLICATION.

**THE PARSONS MOTOR CO., LTD.,**
**Town Quay Works, SOUTHAMPTON.**
'Grams: "MOTORS." 'Phone 4662.

Contractors to the—
ADMIRALTY.
—
WAR OFFICE.
—
AIR MINISTRY.
—
INDIA OFFICE.
—
CROWN AGENTS FOR THE COLONIES.
—
H.M. CUSTOMS,
Etc., Etc.

1269



# MAAG GEARING—

has the advantages of silence and thorough reliability, even under the most adverse of conditions.

It is ideal for electrically driven compressors, pumps, haulages, cranes, winches, or any other drive when the service is especially severe.

Of the pair shown, which are for an Electrically driven compressor, the pinion is nickel chrome steel, case hardened, and accurately ground on the flanks of the teeth. For full details of Maag Gearing write :—

**GEORGE ANGUS & Co. LTD**
Angus Gear Works,
NEWCASTLE-ON-TYNE. 1719

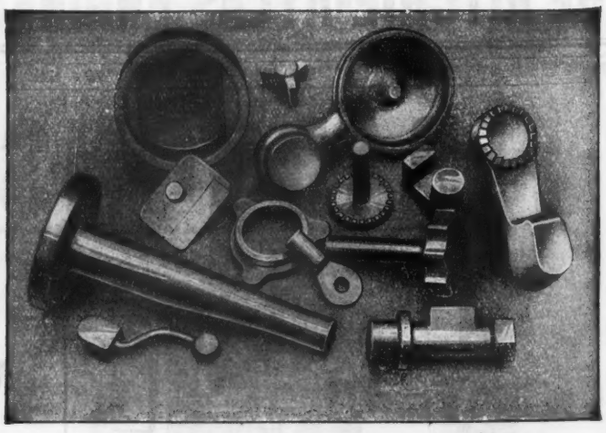
# LEA COAL METERS
"BY THE TON."

The above Photo shows about a "A TON" of these Machines awaiting dispatch.

LEA COAL METERS ARE NOW BEING MANUFACTURED BY
**STANDARDISED METHODS.**
We are therefore able to offer
SPECIAL TERMS FOR QUANTITIES,
for the equipment of Large Boiler Houses.

*Write for full particulars to :*
THE LEA RECORDER CO., LTD.,
28, DEANSGATE, MANCHESTER. 1394

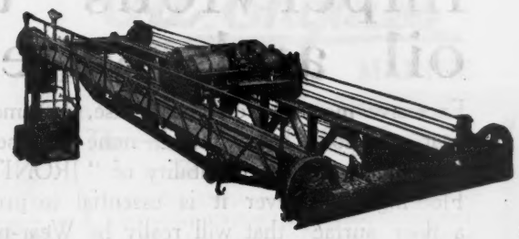
# DIE-PRESSINGS
(SOLID)
## IN BRASS.



ADVANTAGES—
SMOOTHNESS, UNIFORMITY, RELIABILITY, MACHINES FREELY.

**BROOKES & ADAMS, LTD.**
865
BARR STREET,
HOCKLEY, BIRMINGHAM,
ENGLAND.
Tel.—23 North. Tel. Add.—"Telaba."
MAY WE ADVISE OR QUOTE YOU?

ELECTRIC BEDFORD CRANES.



1177

BEDFORD·ENGINEERING COMPANY

BEDFORD ENGLAND.

LANCASHIRE

BOILERS

IN STOCK & PROGRESS FOR EARLY DELIVERY.

WILSON BOILERMAKERS, LTD., 1215

LILYBANK WORKS, GLASGOW.

An Investment, not an expense.

Even if you do have to pay a little more for Citroën Gears, the extra cost is more than justified, and is repaid again and again by what you save in renewals. The high degree of precision attained in the manufacture of

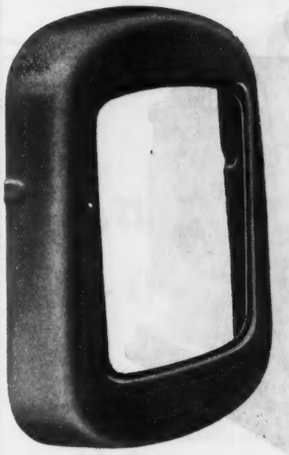
Citroën Gears

combined with their correct tooth form and contour, all tend to render wear and tear negligible. We can refer you to sets which have been in constant use for 10—12 years and which are as good as the day they were installed.

We welcome your enquiries for spur or bevel gears and will send the Citroën Gear Catalogue —a handsome and informative volume on Gear Transmission, free on request.

THE CITROËN GEAR CO., LTD.,
22, Buckingham Gate, London, S.W.1.

1370



RADIATOR CASING.

Sole manufacturers of the steel furniture bearing this celebrated trade mark: Sankey Sheldon

Enquiries to Sole Distributors (Steel Furniture only), Harris & Sheldon, Ltd., 46, Cannon Street, London, E.C.4.

SANKEY PRESSINGS and STAMPINGS

*For Railway and General Engineering Work.*

Stamped or hydraulically pressed work, welded or riveted work, either with or without machining, is undertaken on your own particular specifications, and guaranteed to be of the very highest quality.

Moreover, we can assemble the pressings or stampings into any desired finished article or component.

JOSEPH SANKEY & SONS, LTD.,
HADLEY CASTLE WORKS, WELLINGTON, SHROPSHIRE.

*Telephone: Wellington, Shropshire 66.* 1412 *Telegrams: "Sankey, Wellington, Shropshire."*

We make all descriptions of Hoppers, and Cyclones, for Coal, Grain, Sugar, Dust Extraction, &c., &c.

1393

F. BRABY & Co., Ld.,

Chief Offices:—352 to 364, Euston Road, London, N.W. 1.
Works:—London, Deptford, Liverpool, Bristol, Glasgow, Falkirk.

## BUILT ACCORDING TO WORKING CONDITIONS

We specialise in A.C. Motors. We build A.C. Motors for every purpose and design each type of motor according to intimate experience of the conditions it is intended to work in. For this reason we are able to offer a complete range of machines for driving every class of industrial machinery.

The first quality of a Parkinson A.C. Motor is reliability, and for this reason all Parkinson Motors are sturdily designed throughout. They are provided with damp-proof micanite insulation, all parts are made to standard design and are easily accessible and interchangeable.

Parkinson Motors are built in the largest works in the British Empire devoted exclusively to the manufacture of A.C. Motors. Through rigid adherence to standardisation we are able to produce these motors at an extremely low figure.

Parkinson A.C. Motors are built in all standard sizes from 1 to 300 B.H.P.

**SEND FOR OUR ILLUSTRATED FOLDER S106.**

*Simple, Reliable, Thorough Throughout.*

F & A. PARKINSON LTD

GUISELEY LEEDS

*BRANCHES:*

*LONDON:* 39, *Victoria Street, S.W.1.*
*MANCHESTER:* 20, *St. Anne's Square.*
*BIRMINGHAM:* *Grenville Bldgs.*, 12, *Cherry Street.*
*GLASGOW:* 69, *St. Vincent Street.*
*NOTTINGHAM:* 6, *Arundel Street.*
*CARDIFF:* *Atlantic House*, *St. Mary Street.*

*Also at Amsterdam, Brussels, Invercargill, Buenos Ayres, Melbourne, Sydney, Perth, W.A., Bombay and Shanghai.*

1063

# 'Ironite' Floors

are

# impervious to oil and water.

Excessive moisture, oil and grease, extremes of heat and cold, heavy traffic—none of these has any effect on the durability of "IRONITE" Flooring. Wherever it is essential to provide a floor surface that will really be Wear-proof, Waterproof, Oil-proof and Dustless, specify "IRONITE."

*For further particulars and prices write to:—*

**THE IRONITE COMPANY, LIMITED,**
**11, Old Queen St., Westminster, London, S.W.1.**

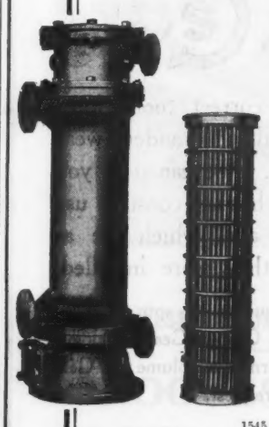
*'Phone: Victoria 5618.* *'Grams: "Thermotvin, Parl, London."*
MANCHESTER: Lyons Road, Trafford Park.
*'Phone: Trafford Park 27.* *Tel. Address: "Conway, Manchester."*
NEWCASTLE: Day & White, Ltd. SCOTLAND: M'Creath, Taylor & Co., Glasgow.
INDIA: Heatly & Gresham, Ltd., Calcutta, Bombay and Madras.

823

*For WATERPROOFING Cement, Bricks, Concrete, Reservoirs, etc., at very low cost and with minimum trouble use* **IRONITE and Cement Slurry.**

# If your problem is COOLING OIL

## PUT IT UP TO SERCK



**TWO heads are better than one, and our experience and advice in all such technical matters are at your service for the asking. We have the largest and most complete plant for the production of SERCK OIL COOLERS which in practice are proved to be the most compact, least costly and most efficient yet invented. A big claim you may think, but let us *prove it.***

**We shall be pleased to give you full demonstration and evidence, with estimates for your own particular problem.**

*SEND TO SERCK for Oil Coolers, Light Gauge, Non-ferrous Tubes, and Drying and Heating Plants for all purposes.*

**SERCK RADIATORS, LTD.**
**Warwick Road, Greet,**
**BIRMINGHAM.**

*Telephone: Victoria 531 (3 lines).*
*Telegrams: "Nerleah, Birmingham."*

**BRANCH FACTORIES AT LONDON, CARDIFF, CHESTER, MANCHESTER, NEWCASTLE AND SUDBURY (Suffolk).**

Agents for the North of England:—Messrs. Smith, Lemon and Stewart, Newcastle-on-Tyne and Leeds.
Agents for Scotland:—Messrs. Munro & Young, Glasgow.

1545

H.P.

# Vickers-Petter Oil Engines

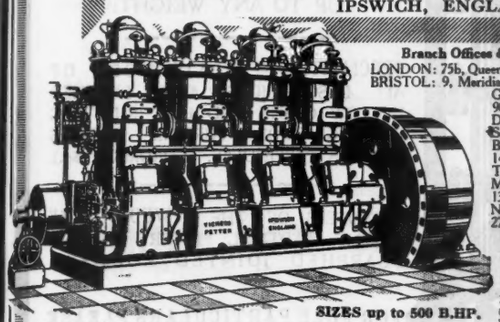
**INDUSTRIAL and MARINE.**

***The World's best Oil Engine— 30 years' Reputation.***

THESE ENGINES are suitable for all kinds of Industrial, Electric Lighting and Marine work, and are famous for their safety, reliability, perfect combustion, and easy accessibility to all parts.

They are of low compression and work smoothly and quietly on any kind of Crude Oil, with a very low fuel and lubricating oil consumption, running on light load for unlimited periods. Only the best materials are used, their construction being simple and robust, and requiring the minimum amount of floor space.

**VICKERS-PETTERS, Ltd.,** Head Office and Works, IPSWICH, ENGLAND.



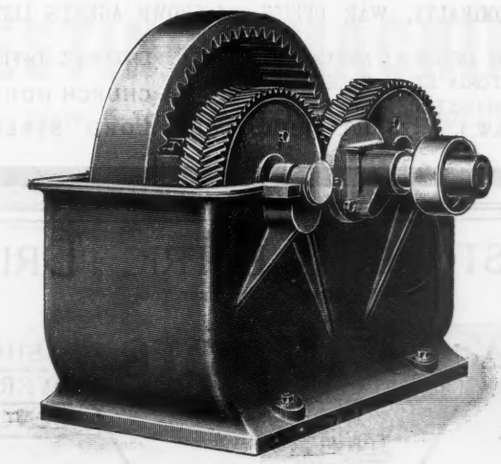
**SIZES up to 500 B.HP.**

Petter Engines are also manufactured from 1½ B.H.P. upwards for working on paraffin, petrol, or town gas. Particulars on application to Petters Ltd., Yeovil.

**Branch Offices & Showrooms:**
LONDON: 75b, Queen Victoria St., E.C.4.
BRISTOL: 9, Meridian Rd., Redland.
GLASGOW: 98, West Regent St.
DUBLIN: 30, Lower Sackville St.
BIRMINGHAM: 14, Union Chambers, Temple Row.
MANCHESTER: 133, Royal Exchange.
NEWCASTLE: 27, Quay Side.
PENRITH: 5, Wordsworth Terrace.
SHEFFIELD: 13/15, Sheaf St.
GRIMSBY: Messrs. Nicholson Bros., Ltd., Nibrono Works. 1630



# GEARS.



**ALL SIZES AND DESCRIPTIONS MACHINE-CUT OR MOULDED.**

**SPECIALLY EQUIPPED FOR URGENT BREAKDOWN WORK AND REPAIRS.**

1703

*— Send for Detailed List and Prices.*

**LLEWELLAN'S MACHINE CO., BRISTOL, ENGLAND.**

TELEGRAMS AND CABLES: "LLEWELLIN'S, BRISTOL." See NEXT WEEK'S ADVERT.



**G.E.C.**

# An Announcement

## The General Electric Co., Ltd. Traction Dept.

AFTER careful study of the principal systems of Electric Traction in this and other countries, and by virtue of an arrangement with Les Ateliers de Construction Oerlikon, Switzerland, The General Electric Co., Ltd., has established an Electric Traction Dept. and is now able to manufacture and supply a complete range of Electric Traction Plant and equipment of the most modern design and highest quality for both D.C. and A.C. systems.

**THESE EQUIPMENTS WILL BE MADE THROUGHOUT AT THE WITTON ENGINEERING WORKS OF THE COMPANY.**

*The General Electric Co., Ltd., is prepared to carry out*

**COMPLETE RAILWAY ELECTRIFICATION CONTRACTS OF ANY MAGNITUDE BOTH AT HOME AND ABROAD**

*supplying power and sub-station plant, buildings, distribution systems, rolling stock, locomotives, etc., and equipping the line in complete readiness for service.*

The very large range of traction designs, together with the thirty years' accumulated traction experience of The Oerlikon Company, combined with the manufacturing resources of The General Electric Co., Ltd., places this company in the most favourable position for undertaking this class of work.

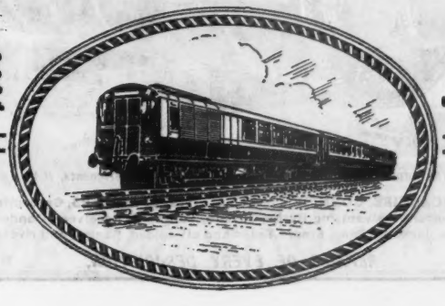
*The services of trained engineers, and data and experience of the widest nature, is gladly offered for the elaboration of any Traction scheme or project.*

**THE GENERAL ELECTRIC CO., LTD.**

Traction Dept.,
Head Office: MAGNET HOUSE, KINGSWAY, LONDON, W.C.2.

1803

Engineering Works { WITTON WORKS, BIRMINGHAM. FRASER & CHALMERS ENGINEERING WORKS, ERITH, KENT.



SIEMENS (S M S) PROCESS
ESTD TRADE MARK 1872
"HALLSIDE"

CONTRACTORS TO—
BRITISH ADMIRALTY, WAR DEPT., and FOREIGN and COLONIAL GOVERNMENTS.

*Manufacturers of—*

**MILD STEEL PLATES, ANGLES,** Zed Bars, Tees and all forms of Sectional Bars required for Ship, Boiler, and Bridge Building, and other constructive purposes.
**CASTINGS** of all kinds and largest sizes for Ship Stems, Sterns, Posts, Anchors, Rudders, &c.
**RAILS, BILLETS, FORGINGS.**
**AXLES** of highest quality, to meet the requirements of Home and Colonial Railways.
**TYRES.**—Locomotive Carriage and Wagon, to all requirements.
**SPECIAL STEEL** of all kinds for constructive purposes.

THE . . .
**STEEL COMPANY of SCOTLAND**
LIMITED.
23, ROYAL EXCHANGE SQUARE,
GLASGOW.
TELEGRAPH ADDRESS "STEEL" GLASGOW. 8314

**"The Lancaster"**
**SUPER-LIMIT PISTON RINGS.**

CLOSED OPEN

Specially designed to meet the increased pressures and speeds now obtained.

**LANCASTER & TONGE, LTD.,**
Makers of "The Lancaster" Steam Traps, Metallic Packings, Steam Dryers, Limit Piston Rings, Spiral Springs, Machine Moulded Wheels, &c. O8926
*Pendleton, MANCHESTER.*
Telegrams—"PISTONS, Manchester." Telephone—794 PENDLETON.

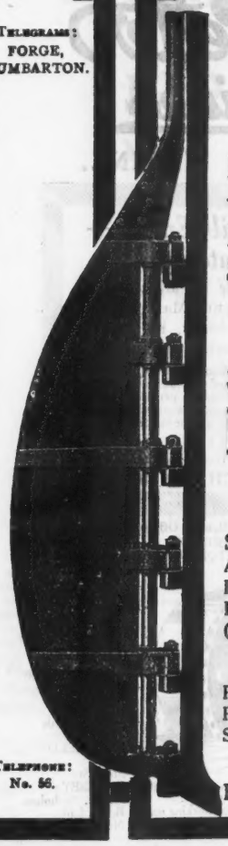
**TINKER, SHENTON & Co. LTD.**
HYDE, Near MANCHESTER.
TELEGRAMS— DUPLEX, HYDE. TELEPHONE— 21, ASHTON-U-LYNE.

*Contractors to The Admiralty, War Office, Home and Colonial Governments, H.M. Office of Works.*

Makers of **LANCASHIRE, CORNISH** and all other types of **BOILERS,** Creosoting Cylinders, Superheaters, Galvanizing Baths, Girders, Tanks, Air Receivers, Condensers, Shells, Hoppers, Jacketed Pans, Steam Trays and all welded, flanged and riveted work.

*REPAIRS OF EVERY DESCRIPTION.* 8175

TELEGRAMS: FORGE, DUMBARTON.



TELEPHONE: No. 56.

EXCEPTIONALLY QUICK DELIVERY GIVEN FOR
FINISHED CRANK SHAFTS,
PROPELLER SHAFTS
with Continuous Gun-Metal Liners complete, and
STERN AND RUDDER FRAMES.

**STEEL AND IRON FORGINGS**
UP TO ANY WEIGHT.

SPECIALITIES:—REPAIR WORK OF ALL DESCRIPTIONS, ALSO FINISHED HOLLOW CRANK AND LINE SHAFTING FORGINGS FOR TURBINE ENGINES (WHEELS, SPINDLES, DRUMS, &c.).

PATENTEES OF THE "WEDGWOOD" PATENT VERTICAL INTER-LOCKING SCARPHED JOINTED RUDDERS.

FOR FULL PARTICULARS PLEASE WRITE:

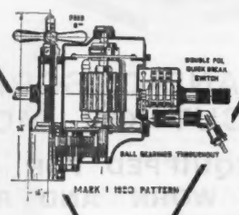
**DENNYSTOWN FORGE CO.**
DUMBARTON. 1421

ON ADMIRALTY, WAR OFFICE and CROWN AGENT'S LISTS.

LONDON OFFICE: 39, VICTORIA ST., WESTMINSTER, S.W. 1.
NEWCASTLE OFFICE: PRUDENTIAL BUILDINGS.
BELFAST OFFICE: 101, BRIDGE END.
LIVERPOOL OFFICE: CHURCH HOUSE. LORD STREET.

**WESTOOL ELECTRIC DRILL.**
THE WESTOOL IS THE BEST TOOL.

EXTRA LONG FEED. **3 Points.** SHORT OVERALL LENGTH.




*There are other Points.*
. . .
*Are you interested?*

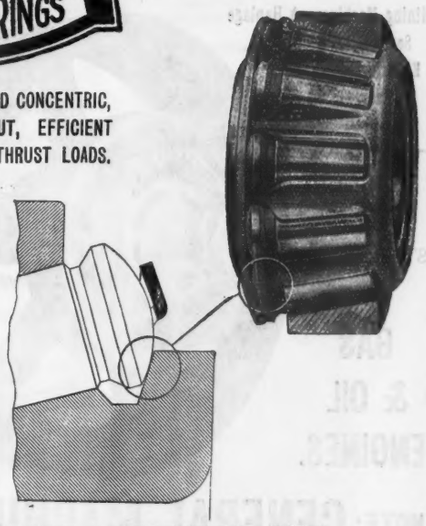
THE WESTMINSTER TOOL & ELECTRIC CO.,
WESTOOL WORKS, PUTNEY, LONDON.
*Telegrams: "Westoleico, Put, London."*
*Telephone: - Putney 1179.*
*GLASGOW OFFICE: 72, Waterloo Street. Telephone Central 1841.*

**BALL BEARINGS THROUGHOUT.** 9451

BRITISH BOCK
BBB
ADJUSTABLE TAPER ROLLER BEARINGS

ADJUSTABLE TAPER ROLLER BEARINGS.

FRICTIONLESS, ACCURATE AND CONCENTRIC, ALLOY STEEL THROUGHOUT, EFFICIENT CARRIERS OF RADIAL AND THRUST LOADS.



Suitable for all types of Motor Vehicles, Heavy Rolling Stock and Industrial Machinery.

May we send you particulars?

**BRITISH BOCK BEARINGS LTD.,**
10, Princes Street, Westminster, S.W. 1.
Telephone: VICTORIA 5472.
WORKS:
120, Cornwall Street, Glasgow.
Telephone: IBROX 68.
1253

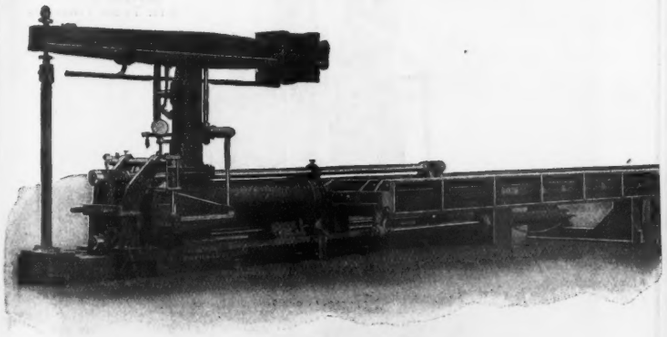
**PERFORATED PLATES FOR REVOLVING AND SHAKING SCREENS.**

G. A. HARVEY & Co. (LONDON) Ltd
WOOLWICH RD LONDON SE7

'Phone: Greenwich 20 (6 lines). Telegraphic Address: "Cheaper Char, London."
1660

**BUCKTON TESTING MACHINES**

from 5 tons to 1000 tons capacity.



HORIZONTAL CHAIN CABLE TESTING MACHINE.

**JOSHUA BUCKTON & Co., Ld.**
MACHINE TOOL MAKERS.
**LEEDS, ENGLAND.**
ESTABLISHED 1843. INCORPORATED 1886.
Cable Address:—"BUCKTONS, LEEDS." 1285
Codes:—A.B.C., 4th & 5th Edition. A 1, New Business, Bentley's Complete Phrase.

Cheap pipe joint compound costs you a farthing per joint.

Smooth-On No. 3 ensures tight joints for an extra farthing.

**Isn't it worth that extra farthing to make this joint tight for all time!**

WHAT'S a farthing compared with labour and material costs in remaking a screw-thread joint? That extra farthing for Smooth-On means perfect service in after years.

Smooth-On keeps joints tight because its metallic iron body can't dry out, crack, shrivel or shrink—yet the joint can be unscrewed.

Smooth-On No. 3 comes ready to use. Sold everywhere in 1, 5 and 10 lb. grey-labelled cans.

Write for the free Smooth-On Instruction Book, which explains all grades of Smooth-On and what each can do.

*Distributors for Great Britain:*
WALTER P. NOTCUTT, LTD.,
8, White St., Moorfields, London, E.C.

Made by Smooth-On Mfg. Co., Jersey City, N.J., U.S.A.
Od 5108 3-10

*Do it with* SMOOTH-ON

HOPKINSON'S PATENT SAFETY

# BOILER MOUNTINGS AND VALVES

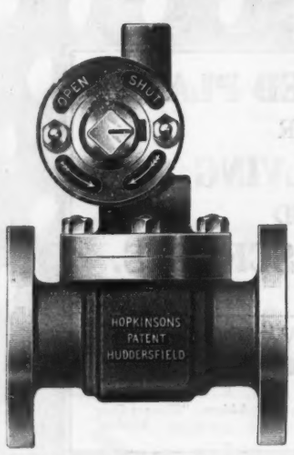



FIG. 2540. HOPKINSON'S PATENT PARALLEL SLIDE BLOW-OFF VALVE, WITH PATENT "OPLOK" PINION.

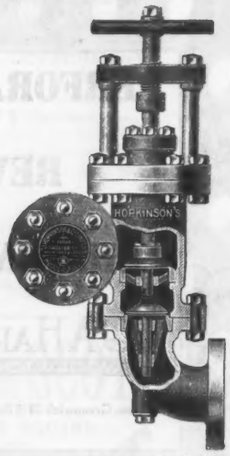



FIG. 1320. HOPKINSON'S PATENT "ACCESSIBLE" CHECK FEED VALVE.

HOPKINSON'S SPECIALITIES CONTAIN SAFETY IMPROVEMENTS WHICH PROTECT THE USER AND ARE RENOWNED FOR HIGH QUALITY AND DEPENDABILITY.

J. HOPKINSON & CO LTD
HUDDERSFIELD

TELEGRAMS "HOPKINSON HUDDERSFIELD" TELEPHONE HUDDERSFIELD 1289 (3 LINES)

A560/1176 1639



# ARCHIBALD EDMESTON & SONS, LIMITED.

FATRICROFT.

# PATENT FRICTION CLUTCH.

300,000 HP. IN SUCCESSFUL OPERATION.

INVALUABLE FOR DRIVING:

Mining Machinery & Haulage
Saw Mills,
Electric Light and Power.

Concrete and Brick-making Machinery, Flour Mills, Textile Machinery, and Mine Gearing Generally.

FOR STARTING

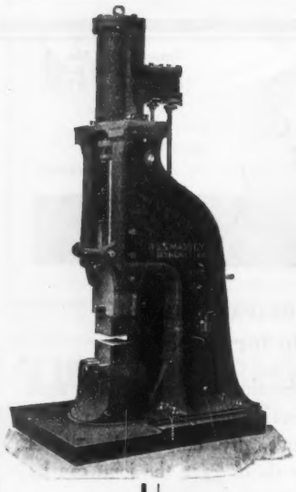
GAS & OIL ENGINES.

FOR COUPLING SHAFT-ENDS

NOTE: GENERAL MACHINE PLANING UNDERTAKEN FOR THE TRADE. 1420

Capacity of Machine, 6 ft. by 6 ft. by 22 ft.





# AN ACCURATE MACHINE-TOOL!

■ ■ ■

MASSEY

Steam Hammers really are Machine-tools.

The same care is exercised in their design, the same methods of precision adopted in their construction.

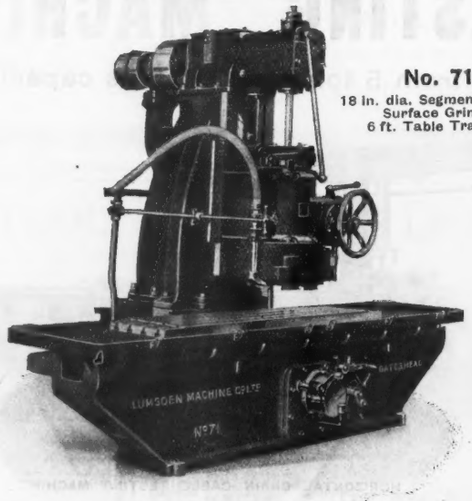
Take the valves for instance—All are ground externally, and all Valve-Tubes internally, after being fixed in the Valve-chest; and a perfect fit is thus secured.

■ ■ ■ 1178

# B. & S. Massey, Ltd.,
OPENSHAW.



# LUMSDEN




No. 71.
18 in. dia. Segmental Wheel Surface Grinder.
6 ft. Table Traverse.

## STOCK REMOVING
SEGMENTAL WHEEL SURFACE GRINDERS.

Vertical. Rotary Table. | Horizontal. Traversing Head. | Planetary. Oscillating. | Traversing Table. Openside Precision Periphery Type.

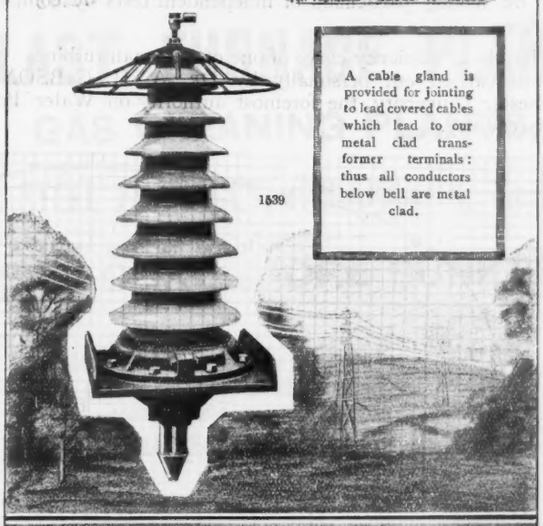
TOOL GRINDERS.

Oscillating. Plain Cup Wheel. Periphery. Curved Lip. Gauge & Form. Floor Type.

**The LUMSDEN MACHINE Co., Ltd., GATESHEAD.**

Telegrams: "Expert, Gateshead." 1532 Telephone: No. 161, Gateshead.

# Sealing Bells
FOR POLE LINE CABLES
(OIL FILLED)
FOR VOLTAGES = 33000 TO 110,000



A cable gland is provided for jointing to lead covered cables which lead to our metal clad transformer terminals: thus all conductors below bell are metal clad.

1539

REYROLLE & CO. LTD.
HEBBURN ON TYNE.

# COCKBURN'S
LIMITED
CARDONALD
GLASGOW
The World Renowned Steam Valve Specialists

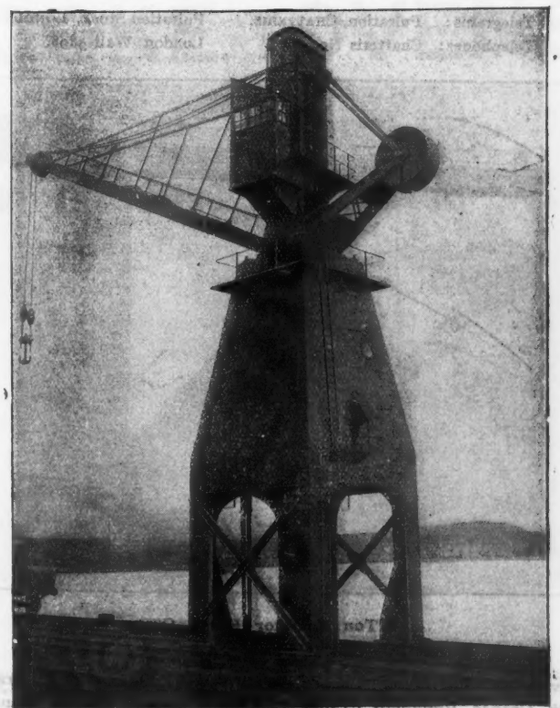
Codes: A B C 5th Edition. Liebers.
Telephone: 361 Govan (3 lines).
Telegrams: "Cockburn, Glasgow."

## SPIRAL SPRINGS FOR ALL PURPOSES

STEERING GEAR BUFFER SPRINGS
A SPECIALTY.
*PLEASE ASK US TO QUOTE.*

1576

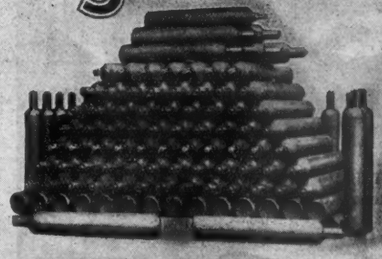
# EAST FERRY ROAD ENGINEERING WORKS CO., LTD.
Hydraulic Cranes and Coal Hoists, Hydraulic Presses of all descriptions,
Patent Pneumatic Grain Elevating Machinery.



1713

15 TONS CAPACITY, DOUBLE POWER, FIXED HYDRAULIC CRANE.
General Engineers and Ironfounders. Estimates given for Repairs.
Tel.: HYDROSTATIC, 'Phone, LONDON. MILLWALL, LONDON, E.

ON ADMIRALTY, WAR OFFICE, AND INDIA OFFICE LISTS
# Cylinders
CODE
A. B. C.
5TH & 6TH EDITIONS



## Weldless Steel Cylinders
for Carbonic Acid, Hydrogen, Oxygen, Ammonia and other Compressed Gases
Diesel Engine-Starting Bottles and Air Receivers.

The CHESTERFIELD TUBE Co. LTD.
CHESTERFIELD, ENGLAND.
ENQUIRIES TO BE SENT TO THE WORKS CHESTERFIELD

# PROCTOR'S PATENT SHOVEL STOKER
AND
## MOVING FIRE-BARS
Give ECONOMY in FUEL,
Increased Steam Production,
SMOKE ABATEMENT.

## PROCTOR'S COAL ELEVATOR,
fitted with Patent RAM FEED BOOT,
Ensures cheap handling of the coal.

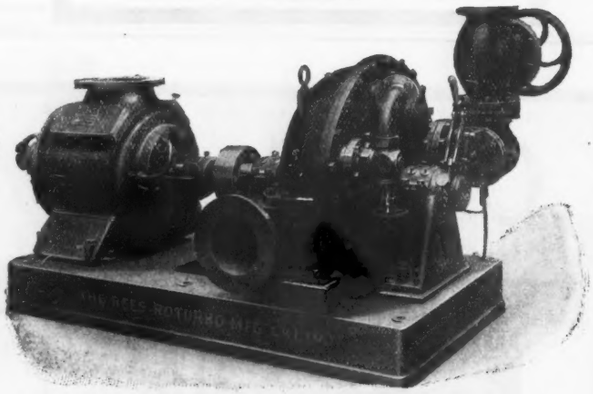
**POSITIVE FEED OF COAL TO BUCKETS. NO JAMMING OF ELEVATOR.**

Wear and Tear reduced to a minimum. Write for Illustrations and Particulars. Od 2945

## JAS. PROCTOR LD., Hammerton St. Iron Works, BURNLEY.

SOLE AGENTS FOR FRANCE AND BELGIUM:
The Societe des Perfectionnements a la Vaporisation, 68, Rue de Rome, Paris.

# REES RoTURBo
## TURBINE PUMPS
FOR ALL PURPOSES.



Rees RoTURBo single stage Pump coupled to Rees RoTURBo Steam Turbine.

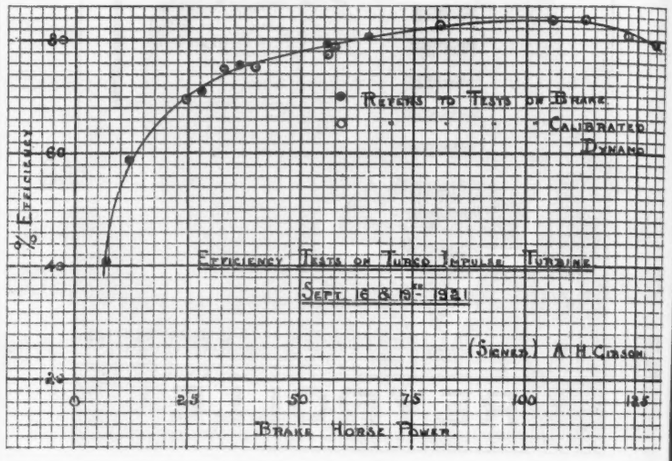
Highest Efficiency — Maximum Reliability

ILLUSTRATED PAMPHLET ON APPLICATION. 1404
Quote R191—B.

## THE REES ROTURBO M'FG. CO., LTD.,
Hydraulic, Electrical and General Engineers,
Head Office and Works: WOLVERHAMPTON, England.
LONDON OFFICE: Hastings House, Norfolk Street, Strand, W.C.

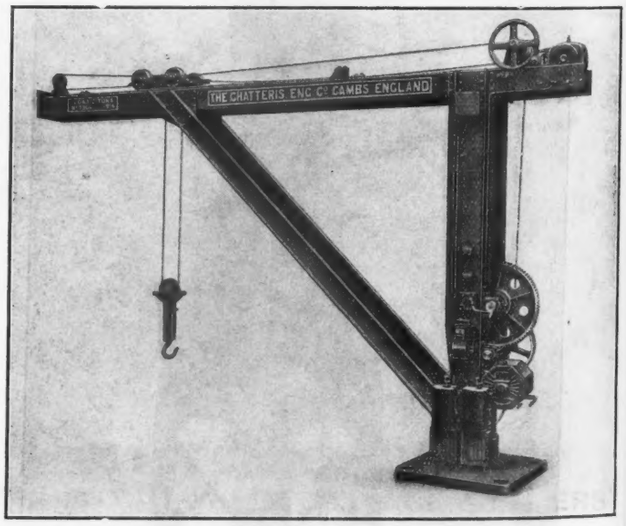
# WATER TURBINES.
## HIGH EFFICIENCY
is an essential requirement in all modern turbines. Tests at makers' own works cannot be unbiassed. Insist on having particulars of independent tests by competent authorities.

Here is an efficiency curve of one of our small turbines. The test was carried out personally by DR. A. H. GIBSON, of Manchester University, the foremost authority on Water Power in this country.




## GILBERT GILKES & Co. Ltd., KENDAL, ENG.
87V

## THE CHATTERIS ENGINEERING CO., LTD.,
Works: CHATTERIS, CAMBS.
London Office: 139/40, Gresham House, E.C. 2.
Telegrams: Pulsation, CHATTERIS. Pulsation Stock, LONDON.
Telephones: Chatteris No. 3. London Wall 5898.




3 Ton 2 Motor Forge Crane.

*Also makers of*
Overhead Travelling Cranes, Wall Cranes, Fixed and Travelling Jib Cranes, Runabout Cranes, Capstans, Friction Hoists, Transporter Cranes, Winches, and Lifting Machinery of all descriptions.
SPECIALISTS IN GOLD AND DIAMOND MINING MACHINERY. 1380

# Ashmore, Benson, Pease & Co.,

LIMITED,

**STOCKTON-ON-TEES.**

Makers and Erectors of

## BLAST FURNACE PLANT,

**GAS CLEANING PLANTS,**

**STEEL FURNACES, PRODUCERS, &c.**

**COAL, COKE & ORE BUNKERS.**

**Cast Iron and Steel Work**
for Coke Ovens and Chemical Plants.

**GAS WORKS PLANT OF EVERY DESCRIPTION.**

1999 **CASTINGS UP TO 20 TONS.**

SOLE MAKERS OF

***Forter's Patent Reversing Valves***

*For Steel, Glass and other Furnaces.*

**WHITECROSS - ARMCO**

**Quality Ingot Iron Electrodes (99·84% Guaranteed Purity).**

*THE HIGHEST GRADE OF COMMERCIALLY PURE IRON.*

1596

*Send us a Post-Card NOW for our Welding Book.*

THE WHITECROSS COMPANY LIMITED
WARRINGTON

Telephone Nos 9, 10, 11, 12 & (LONDON), 657 AVENUE.

Telegrams: "WHITECROSS" WARRINGTON "ARSENIDE, FEN", LONDON

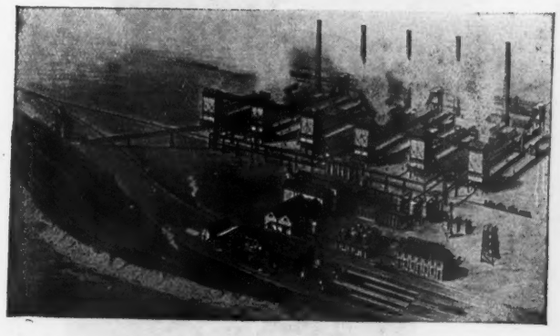
ESTD 1864.



# BYE-PRODUCT COKE OVENS

*SEMET-SOLVAY SYSTEM (Horizontal Flues)*
*and PIETTE SYSTEM (Vertical Flues).*

**DRY QUENCHING OF HOT COKE** (Sulzer Process).

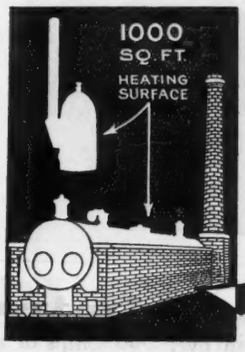


Six Batteries of Piette Ovens at Caen.

**THE**
**SEMET-SOLVAY & PIETTE COKE OVEN CO., LTD.,**
Howard Chambers, 155, Norfolk Street,
**SHEFFIELD.**

1284






# Cochran Boilers

Stocked in 22 sizes for immediate delivery.

*"Instal a "Cochran" & save that brickwork*

1135

HEAD OFFICE & WORKS
COCHRAN & Co ANNAN LTD.
ANNAN, SCOTLAND.
Telegrams MULTITUBE ANNAN
Telephone No 2 ANNAN.

Cochran
& Co. Annan, Ltd, Annan, Scotland.

LONDON OFFICE
76 LOWER BELGRAVE ST.,
Telegrams MULTITUBE SLOANE LONDON
Telephone 2467 VICTORIA.

# The BEST is Demanded for BRITISH Ships.

That is why the BIGGEST SHIPS of the

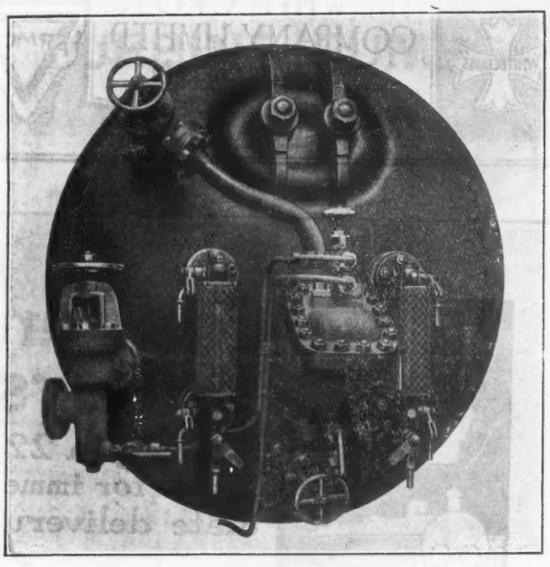
**WHITE STAR, CANADIAN PACIFIC, CUNARD, and P. & O. LINES**

have been fitted with

# MUMFORD'S

***Patent Automatic***

# FEED WATER REGULATOR.



**The British Admiralty,** which has already had it fitted in over 500 Ships of all classes, **has again ordered it for** all boilers of **the New British Battleships.**

It has also been adopted by the JAPANESE, ITALIAN, RUSSIAN, SPANISH, & BRAZILIAN NAVIES.

## A. G. MUMFORD, Ld.

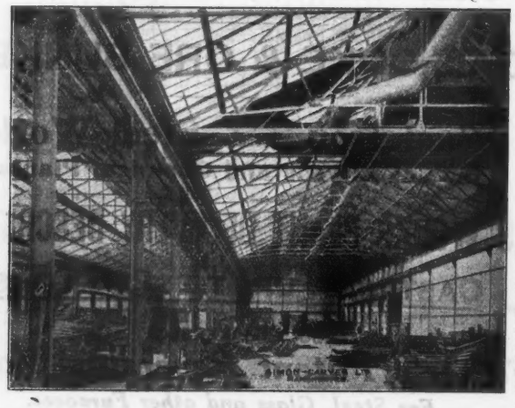
Culver Street Engineering Works,

COLCHESTER.

8376

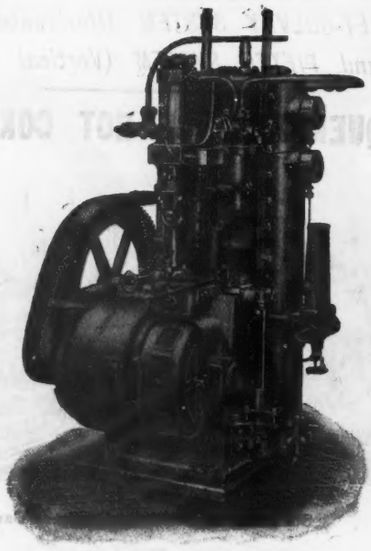
SIMON-CARVES LTD MANCHESTER

# HEATING & VENTILATING FOR FACTORIES & WORKSHOPS




FORCED AND INDUCED DRAUGHT.

# $CO_2$ REFRIGERATING MACHINES NAVAL TYPE.



Telegrams: SEAGERS, DARTFORD.

National Telephone: 26, DARTFORD.

## SEAGERS, LD.

DARTFORD.

1179

HAMBEE

*Washers*

Hambee bright steel washers are an Engineering job for Engineers. They are carefully turned and chamferred, and made to fine limits of accuracy that ensure a clean and efficient assembly. Each size of washer is finished **absolutely** to a standard gauge. Washers of every description, in all metals and at competitive prices, packed in one gross parcels, and clearly labelled, are our speciality. Let us send our price list for future reference.

*Make the BEST of a GOOD job with Hambee Washers.*

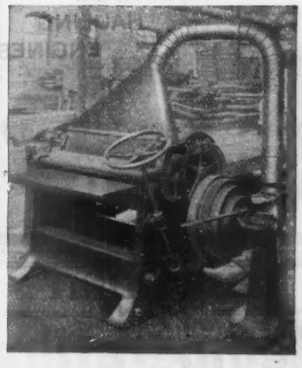
**Hampton & Beebee, Ltd.,**
**Franchise St., Wednesbury, Staffs.**

*That's the surface that matters*

1368

**"Pneumatic Collecting and Conveying"**

WE have just issued a new publication on this subject. The Pneumatic System of refuse collection is dealt with very thoroughly. A number of interesting plants are illustrated as well as the application to particular machines. Details of apparatus are given.



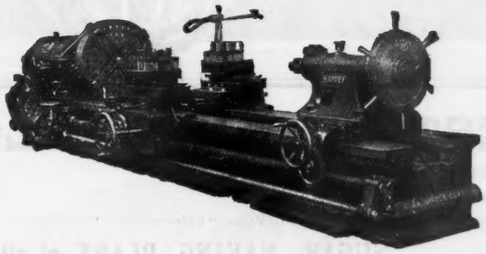
**This book should prove of great assistance to you.**

***Ask for complimentary copy of publication No. "D. 1093."***

STURTEVANT
ENGINEERING Co. LTD.
149 Queen Victoria St., London, E.C.4

1166

HARVEY



**SPECIALITIES.**

**S.S. & Sc. LATHES, 18", 21", 24", 30", 36" Centres, All Gear Heads.**

***Horizontal Drilling, Tapping, & Boring Machines.***
**Spindles 2", 2½", 3", 3½", 4", 5", 6" Dia.**

**G. & A. HARVEY, LTD.**
ALBION WORKS,
GOVAN,
GLASGOW.

Telegrams: "GANDAH."

1181

**PLENTY STATIONARY OIL ENGINES**

Plenty Stationary Oil Engines are designed to embody ample capacity and consequent reliability. They are not of the hot bulb type—a factor we particularly emphasise by describing them as a surface ignition type. Starting from the cold under two minutes' they work on residuum fuel oil, and are specially designed and constructed to fulfil the arduous demands met with in important undertakings such as Electric Supply Stations and Generating Plants for Ships.

*All interested in Stationary Oil Engines should write for Plenty illustrated catalogue, sent free upon request, together with a specimen copy of our monthly publication "Oil Power."*

**PLENTY & SON LIMITED**
KING'S ROAD WORKS, NEWBURY, BERKS.
Telephone: Newbury 7. Telegrams: "Plenty, Newbury."

*Sole Selling Agents for "Plenty" Stationary Oil Engines in the United Kingdom :—*

Messrs. BANKS, WARNER & Co., Ltd.,
Albert Embankment, Vauxhall, S.E.

**Every Plenty Engine Carries a 2 Years' GUARANTEE.**

P.P. 1610

# PRATCHITT

BROTHERS,
Denton Ironworks, CARLISLE.

PUMPING
WINDING AND
HAULING
ENGINES

BRUNDRIT
PATENT
**Temperature Balance**

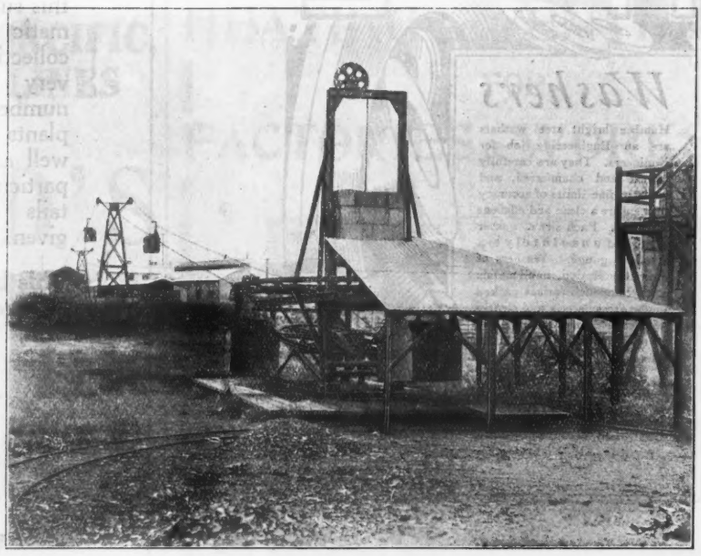
*The*
AUTOMATIC
CIRCULATOR
*For Marine & Land*
BOILERS

**4500 Sets**
already fitted for
the Leading
Steamship Companies

BRUNDRIT'S TEMPERATURE BALANCE is valveless and perfectly Automatic in action. It starts working shortly after Fires are lighted and continues working even under Banked Fires, so long and as often as the Water above and below line of fire bars varies in temperature. Can be fitted at short notice without drilling or structural alteration. *Fitted to all boilers of R.M.S.S. Aquitania and Mauretania.*

JOSEPH BRUNDRIT
*Sole Patentee,*
16 Water St. LIVERPOOL.

"EFFICIENT" ROPEWAYS.



Ropeway handling chemicals between various departments at H M. Factory, Bradley, Huddersfield.

ROBERT DEMPSTER & SONS, LTD.
ELLAND—YORKS.

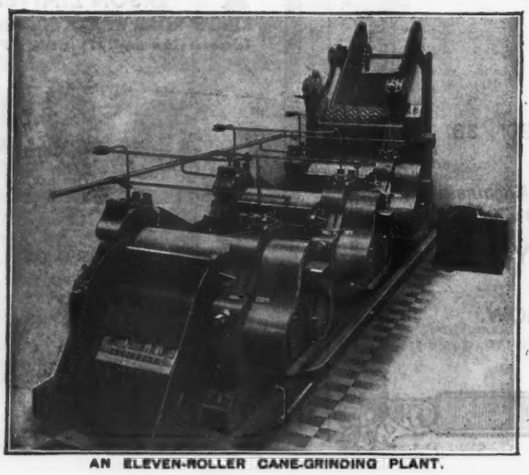
1663

# FAWCETT, PRESTON & CO., Ltd.,

ENGINEERS, LIVERPOOL.

CONTRACTORS TO THE ADMIRALTY AND WAR OFFICE.

Telegrams: FAWCETT, LIVERPOOL. Codes used: A 1, A B C (4th and 5th Editions) and Western Union ("Universal" and "Five Letter" Editions).



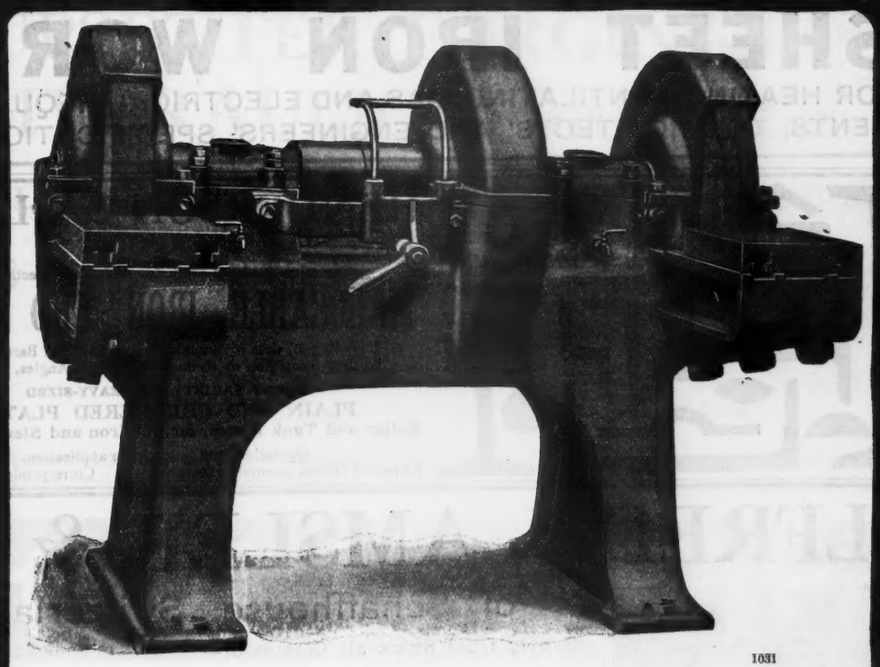
AN ELEVEN-ROLLER CANE-GRINDING PLANT.

**SUGAR MAKING PLANT of all kinds**
Complete Factories Supplied.
**Sea Water DISTILLING PLANT.**
**DISTILLING and EVAPORATING PLANT for all purposes.**
**Hydraulic BALING PRESSES.**
Sole Makers of CYCLONE and GRID PRESSES, and of Fawcett's High Density Presses and Pumps for packing Cotton, Jute, Wool, Hides, &c., of any required density and weight of bale.
**EXPLOSIVES PLANT.**
**NITRATE-MAKING PLANT.**
**MARINE and STATIONARY ENGINES and BOILERS.**
**PUMPING MACHINERY for Towns Water Supply.**
**COPPERSMITHS and BRASS FOUNDERS.**

1772

*LONDON Office: 69, Victoria St., S.W. 1.*

# ECONOMICAL GRINDING.



1031

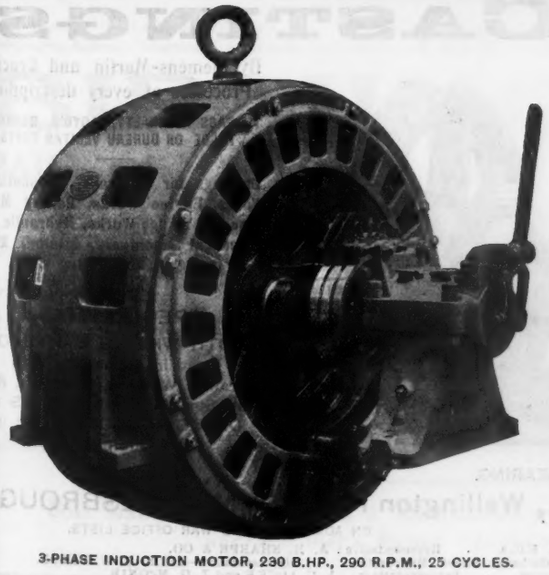
## EMERY WHEELS AND GRINDING MACHINES.

BRITISH MADE.

## L. STERNE & CO., LTD.,

THE CROWN IRON WORKS, GLASGOW.

LONDON OFFICE: DONINGTON HOUSE, NORFOLK ST. W.C.



3-PHASE INDUCTION MOTOR, 230 B.HP., 290 R.P.M., 25 CYCLES.

## J. P. HALL & Co., LTD.

## OLDHAM.

Telephone: 1901 (2 Lines).
Telegrams: "Dynamo," Oldham.

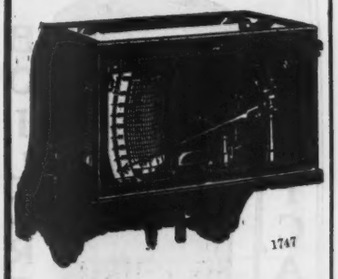
MAKERS OF DIRECT AND ALTERNATING GENERATORS AND MOTORS.

1561

## BUDENBERG GAUGE Co. LTD

(Late Schaffer & Budenberg Ltd.)
BROADHEATH Nr. MANCHESTER.
BRANCHES: LONDON & GLASGOW.

Makers of
PRESSURE GAUGES, Tachometers, Counters, Dial-Thermometers, Test Pumps, &c.



1747

SELF-RECORDING INSTRUMENTS FOR PRESSURE, TEMPERATURE and SPEED.

## PUMPS

Belt or Steam Driven

Vertical or Horizontal

RAM PUMPS FOR MINES.

1531

"SHORE" PATENT FEED WATER HEATER.

FEED WATER HEATERS.

*SEND US YOUR ENQUIRIES.*

## THOS. SHORE & SONS, LTD.

ETRURIA, STOKE-ON-TRENT.

## LAMBETH

COTTON DRIVING

## ROPES.

MADE 3 OR 4 STRAND.

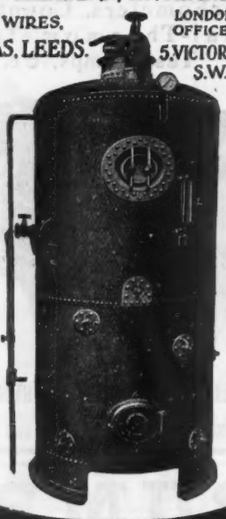
Specially suitable for Drives in Engineering Works, Rolling Mills, Cement Works, Textile Factories & Main Driving Generally.

Book on Rope Driving free on application.

## THOMAS HART, Ld.

LAMBETH WORKS,
BLACKBURN.
1105
Established 1789. ENGLAND.

CLAYTON SON & Co.
LIMITED
WORKS.
LEEDS, ENGLAND.
WIRES. GAS, LEEDS.
LONDON OFFICE. 5, VICTORIA ST. S.W.1.

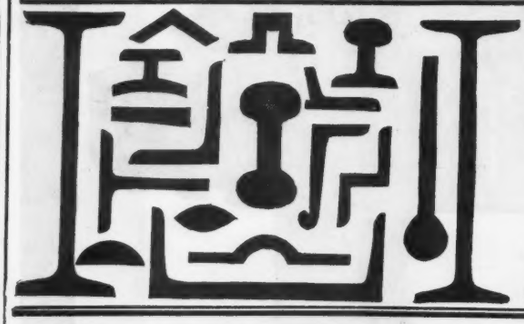


VERTICAL BOILERS

LARGE STOCK READY FOR IMMEDIATE DELIVERY

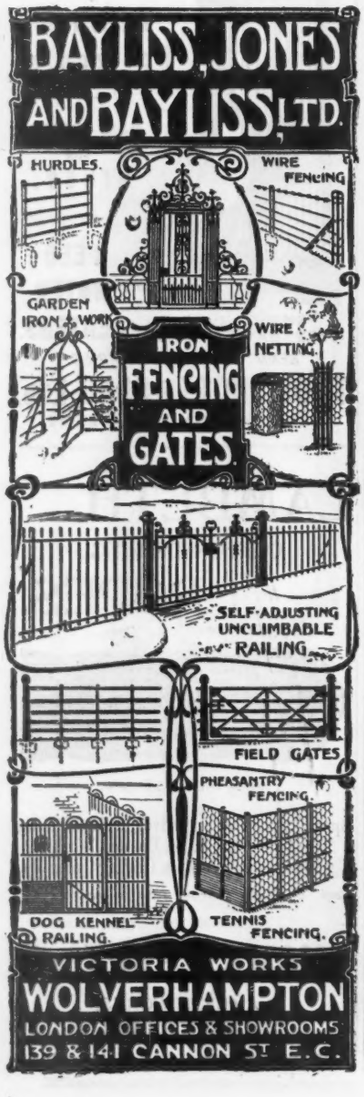
1458

TELEPHONE CLERKENWELL 6218.
ESTABLISHED 1853.
F. T. MYERSON,
215, ST. JOHN STREET, LONDON, E.C. 1.
1403
EVERY DESCRIPTION OF
SHEET IRON WORK
FOR HEATING, VENTILATING, GAS AND ELECTRICAL REQUIREMENTS, TO ARCHITECTS' AND ENGINEERS' SPECIFICATIONS.



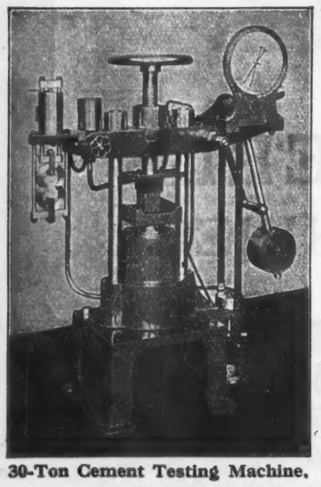
HENDERSON & GLASS,
LIVERPOOL.
Extensive Stocks of every description and Section of
MALLEABLE IRON AND STEEL
Including all sizes of Round, Square, and Flat Bars, Rolled Girders from 3 in. to 20 in. deep; Tees, Angles, &c., &c.
GREAT VARIETY OF HEAVY-SIZED
PLAIN AND CHEQUERED PLATES
Boiler and Tank Plates, &c., in Iron and Siemens Steel.
1707
Quotations and Sections on application.
Shipment Orders promptly executed. Correspondence Solicited.

BAYLISS, JONES AND BAYLISS, LTD.




VICTORIA WORKS
WOLVERHAMPTON
LONDON OFFICES & SHOWROOMS
139 & 141 CANNON ST E.C.

ALFRED J. AMSLER & Co.
of Schaffhouse, Switzerland
Supply from Stock all Classes of—
TESTING MACHINES



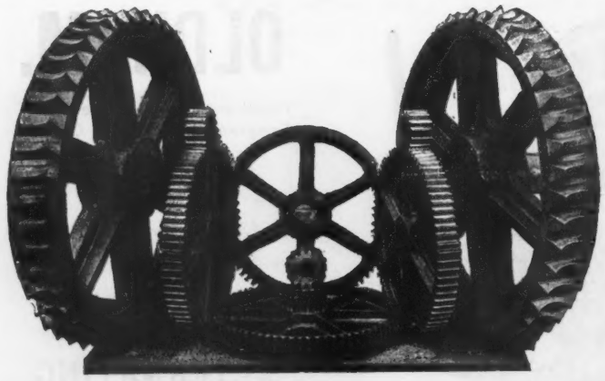
30-Ton Cement Testing Machine.

for TENSION
COMPRESSION
BENDING
BULGING
FATIGUE
IMPACT
HARDNESS
ABRASION
TORSION
SPRINGS
PRESSURE GAUGES
and AXLE LOADS.

for STATIC and DYNAMIC TESTS of WOOD.
ACCEPTANCE TESTS of ANCHORS and CHAINS.
RAILWAY MATERIALS.
ELECTRIC INSULATORS.
CRUSHING CONCRETE up to 1000 tons load.
812 FABRICS and BELTS.

Write for Particulars and Sectional Catalogue to:— T. J. PRIMROSE (Sole Agent), 162, Norwich Rd., IPSWICH.

STEEL CASTINGS.



By Siemens-Martin and Crucible Processes of every description.
TO PASS ADMIRALTY, LLOYD'S, BOARD OF TRADE OR BUREAU VERITAS TESTS.
Castings for Railways, Shipbuilding Yards, Engine Works, Rolling Mills, Iron and Bridge Works, Hydraulic and Electrical Machinery, Mining, River Dredging, Excavating Work.
SPECIALITIES:
TOOTH WHEELS and PINIONS used in connection with Cranes, Winches, Capstans, &c.
Cast-Steel ANCHOR HEADS and DREDGER BUCKETS Fit up Complete.
MACHINE-CUT STEEL GEARING.
W. SHAW & CO., Ltd., Wellington Foundry, MIDDLESBROUGH.
Telegrams—"WELLINGTON, MIDDLESBRO." ON ADMIRALTY AND WAR OFFICE LISTS.
London Office: 90, Cannon Street, E.C. 4. - Representative: A. H. SHARPE & CO.
Office for Manchester and Birmingham Districts: 12, Exchange Street, Manchester. - Representative—THOS. F. W. DIXON.
Glasgow Office: 4, West George Street, Glasgow. - Representatives: A. C. LOCKE and J. G. McCONIE.
Agent for Leeds and District: G. G. S. GRUNDY, 24, Basinghall Street, Leeds.
Agent for Durham and Northumberland: G. NELSON, 109, Pilgrim Street, Newcastle-on-Tyne.
1738

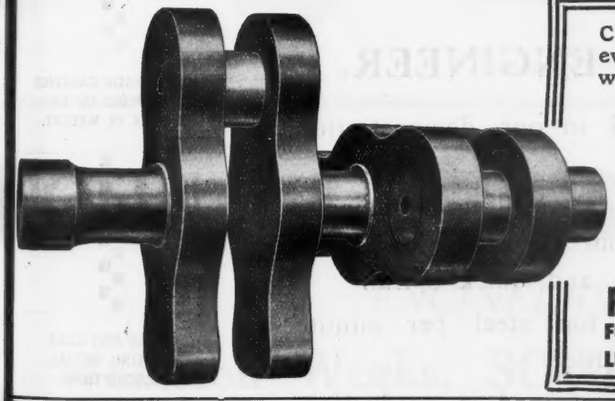
# DROP FORGINGS
# UPSETTER FORGINGS
# HYDRAULIC FORGINGS

— LET US QUOTE FOR YOUR REQUIREMENTS —

THE SCOTTISH STAMPING & ENGINEERING COY., LTD.
AYR, —— SCOTLAND. 1904

Telegrams: STAMPINGS, AYR.
Telephone: 166 AYR.

# Steel Forgings



CRANKSHAFTS and Forgings of every description up to 12 Tons weight.

Machining and Finishing to Standard Limits.

Steel Drop Forgings up to 112 lbs. each.

Rollers of Steel Bars, Rods and Sheets and Special Sections.

Telegrams: "Forge, Rotherham."
Telephone: Rotherham 641. 1568

ROTHERHAM
FORGE & ROLLING MILLS COMPANY, LIMITED, ROTHERHAM, YORKS.

Telephone: No. 296 Smethwick (4 Lines).
Telegraphic Address: "Carriage," Smethwick, Birmingham.

Grand Prix, Buenos Ayres Exhibition, 1910.

# THE BIRMINGHAM RAILWAY CARRIAGE AND WAGON CO., LTD., SMETHWICK.

FOR HOME AND ABROAD.

MANUFACTURERS OF

RAILWAY CARRIAGES AND WAGONS OF EVERY DESCRIPTION, INCLUDING ALL-STEEL CARRIAGES.

PRESSED STEEL UNDERFRAMES, BODIES AND BOGIES. 6931

MAKERS OF RAILWAY WHEELS AND AXLES, IRONWORK, AXLE BOXES, CASTINGS, &c.

Sole Manufacturers of Dean & Churchward's Patent "Eitherside" Brake, and Marillier's Patent "Instanter" Coupling.

## WELLS' INCANDESCENT OIL LAMPS.

FOR INSIDE & OUTSIDE LIGHTING.

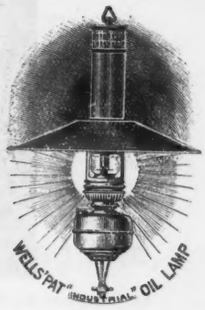
A Brilliant and Shadowless light from Petroleum : or Kerosene :

FOR MILLS, FACTORIES, WAREHOUSES, DOCKS, &c.

Fitted with Special Removable Vaporiser.

No. 38 Lamp, 300 c.p.
39 „ 600 „
40 „ 1000 „

## "INDUSTRIAL" OIL LAMPS.




FOR TEA HOUSES, MILLS, PLANTATIONS, WAREHOUSES.

For Indoor Use Only.
100 c.p. No Glass to Break.
Framework Fitted with Mica Panes.
No. 1, Brass Font, cap. 2½ pts.
„ 2, Steel „ „ 3 „

## WELLS' OIL GAS GENERATING LAMPS

Light from Kerosene or Petroleum, without wick.

NO SMOKE OR SMELL.

Perfect Safety. No Explosive Naphtha used.

Thousands Sold.

Unaffected by wind.

No. 13 ... 5 hours.

## KETTLE TORCH LAMPS.

THOUSANDS SOLD.

Largely used by Contractors, Collieries, Steam Trawlers, Trench Works, &c.

LARGE FLAMING LIGHT.

No. 18. 3 Pints.

(HORIZONTAL) OIL FEEDERS.
With Valves & Brass Tops.
No. 1, ½ pint.

## MOULDERS' LAMP.

Burns ordinary Petroleum or Paraffin. No. 20.

A. C. Wells & Co. 102 Midland Rd., London ST. PANCRAS, N.W. 1
Works: Carnarvon St., MANCHESTER.

# ALFRED HERBERT LTD., COVENTRY.

'Phone: 860 (8 LINES).

Wires: LATHE, COVENTRY.

No. 4 CUTTER GRINDER WILL SHARPEN MOST DELICATE CUTTING EDGE.

JIGS, FIXTURES AND GAUGES SUPPLIED TO CUSTOMERS' OWN DESIGN.

TURRET LATHE TOOLS TO SUIT MACHINES OF OUR OWN AND OTHER MAKES.

HIGH GRADE CASTINGS SUPPLIED UP TO 3 TONS IN WEIGHT.

GEARS AND GEAR CUTTING OF ALL DESCRIPTIONS.

## FOR EVERY PRODUCTION ENGINEER.

EVERY production engineer will be interested in our demonstration department at Coventry.

We have just added an all-geared Horizontal Milling Machine—48 in. by 18 in. by 22 in.—equipped with our new High Power Milling Cutters with curved lip, undercut teeth and quick spiral.

This is removing 32 cubic inches of 35 ton steel per minute without vibration or undue wear of machine or cutter.

There are many other interesting examples of modern production.

***All are Welcome.***

9976

BUCKET CONVEYOR FOR CEMENT, CLINKER AND SIMILAR BULK GOODS.

# COMPLETE PLANTS FOR CEMENT, LIME & BRICK WORKS.

## F. L. SMIDTH & CO., LTD., ENGINEERS,

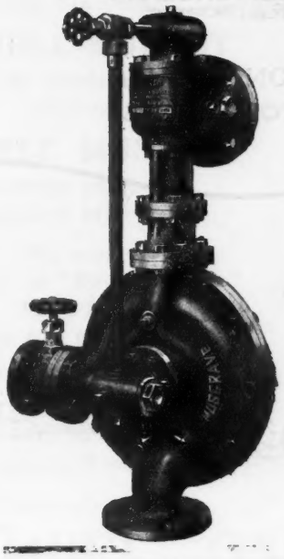
20, ESSEX STREET, LONDON, W.C. 2.

Telegrams: "Chalkiness, Estrand, London." Telephones: Central 8716-17.

**Works:** LUTON, COPENHAGEN, NEW YORK.

1340

# MUSGRAVE



## VACUUM? — THE "RADOJET"

(PATENTED STEAM-JET AIR EJECTOR),

FOR POWER PLANTS and PROCESSES.

Pamphlet from

John Musgrave & Sons, Ltd.,
Globe Ironworks, BOLTON, England,

*Telegrams: "MUSGRAVE," Bolton.* *Codes: ABC (5th & 6th Editions) and A1.*
*Telephone: Bolton 1832 (4 lines).*

*We are exhibiting at the British Empire Exhibition, April—October, 1924.* 1594

# JOHN I. THORNYCROFT AND CO., LIMITED.

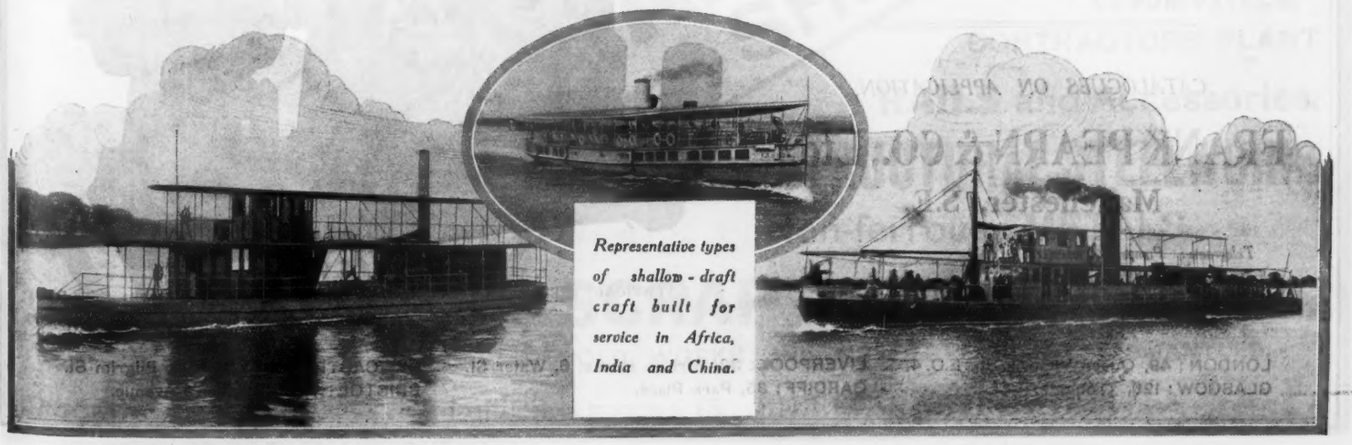
*ENGINEERS & SHIPBUILDERS*

**Woolston Works, SOUTHAMPTON & THORNYCROFT HOUSE, WESTMINSTER, S.W. 1.**

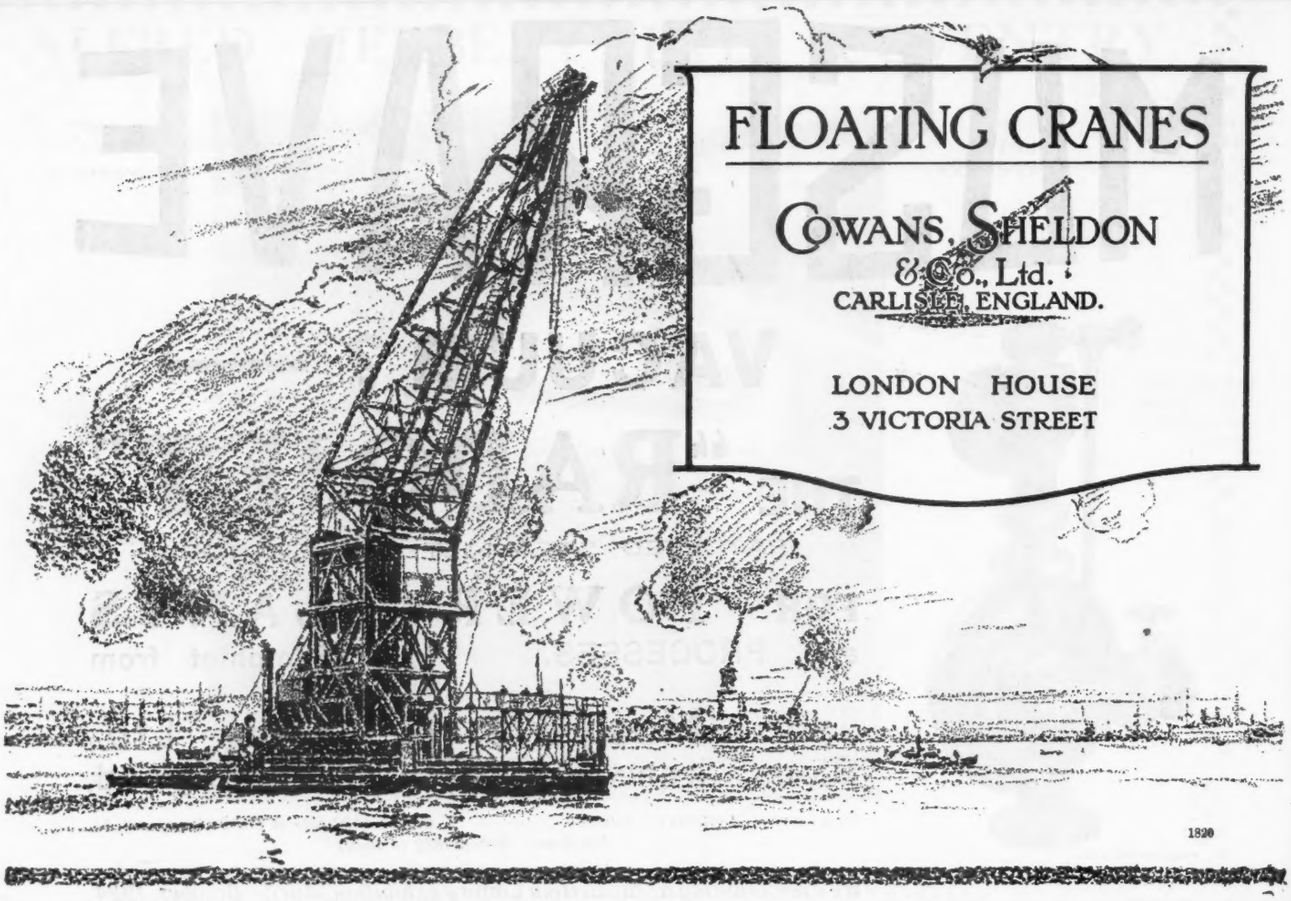
Specialists in the design and construction of shallow-draft and other vessels for uncommon service, complete or in sections for erection abroad.

Builders of Passenger and Cargo Boats to 5,000 tons. Oil Tankers to 8,000 tons. Marine Engines, Steam Turbines, Water Tube Boilers, Oil Fuel Gear, etc. 1123

***Ship Repairers to the Cunard Steamship Co., Limited.***



*Representative types of shallow-draft craft built for service in Africa, India and China.*



# FLOATING CRANES

COWANS, SHELDON & Co., Ltd.
CARLISLE, ENGLAND.

LONDON HOUSE
3 VICTORIA STREET

1820

# PEARN PUMPS

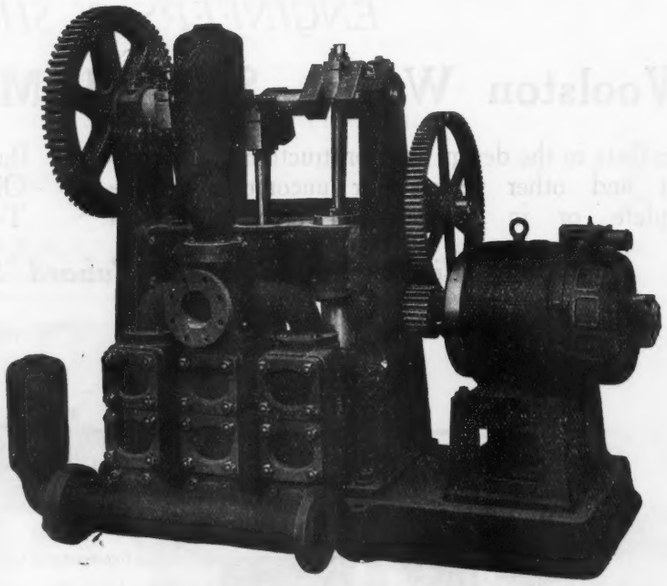
**for all purposes.**
**Steam, Belt or Motor drive.**

**DRY VACUUM PUMPS.**
**WET VACUUM PUMPS**

*CATALOGUES ON APPLICATION.*

**FRANK PEARN & CO., Ltd.,**
**Manchester, S.E.**

*Telegrams: Pumps, Manchester.*
*Telephone: 2289 Central.*



VERTICAL TREBLE RAM PUMP, DRIVEN BY ELECTRIC MOTOR. D 8451

LONDON: 49, Queen Victoria St., E.C. 4.
GLASGOW: 129, Trongate.
LIVERPOOL: 32, African House, 6, Water St.
CARDIFF: 35, Park Place.
NEWCASTLE-ON-TYNE: 90, Pilgrim St.
BRISTOL: 7, St. Stephen's Avenue.

O. 99

OSBORN'S

# "MUSHET" HIGH-SPEED STEEL DRILLS.

We supply Twist Drills in three qualities:—

"MUSHET"
(The Standard),

"DOUBLE MUSHET"
(Greater production, less grinding),

"TRIPLE MUSHET"
(Maximum production, minimum grinding).

We supply "Mushet" & "Double Mushet" Twist Drills in two tempers:
1. Engineers'. 2. Tough.

"Triple Mushet" Twist Drills in Engineers' Temper only.

**10,667 HOLES WITH ONE DRILL.**

Speed—495 r.p.m.
Feed—6 in.
Size of Drill—15/16 in.
No. of Grindings—18.
Material—Mild Steel.

This was accomplished by a Tough Temper "Mushet" High-Speed Steel Twist Drill in the Works of one of our Customers.

**IT MIGHT HAVE BEEN IN YOUR WORKS.**

*Manufactured solely by*

**SAMUEL OSBORN & CO., Limited,** Clyde Steel Works, - SHEFFIELD. - 1347

*Ask for Booklet No. 4.*

MARINE ENGINES & BOILERS,
WEIR PUMPS, WINCHES.
Generating Sets, Electric Fans,
STEERING GEAR. TANKS.
Plates, Planking.
MACHINE TOOLS.

*Catalogues Free.*

Telegrams: "FORWARD, SHEFFIELD."

# THOS. W. WARD LIMITED,

ALBION WORKS, SHEFFIELD.

Telephone: 4321 (8 Lines).

CRANES.
LOCOMOTIVES.
CONTRACTORS' PLANT
RAILS and Accessories.
STRUCTURAL STEELWORK.
Non-ferrous METALS. 1419
SCRAP IRON & STEEL.
OLD WORKS AND OBSOLETE PLANT DISMANTLED.

LONDON OFFICE: 18, BILLITER STREET, E.C. 3.

# MARPLE AND GILLOTT LTD.

WHARNCLIFFE HOUSE
SHEFFIELD

BUYERS AND SELLERS OF

# SCRAP

ALSO:— RAILS, POINTS, CROSSINGS, SLEEPERS, WAGONS AND TIMBER DISMANTLERS AND SHIPBREAKERS. . . . .

'PHONE:—5042 CENTRAL (6 LINES) . . . .
'GRAMS:—"FERRIC," SHEFFIELD. . . . . 1240

CONSTRUCTIONAL IRON & STEEL WORK OF ALL KINDS

GALVANIZED CORRUGATED SHEETS

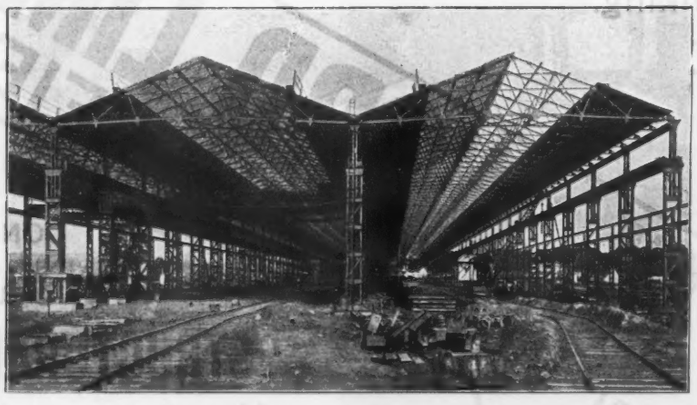
GALVANIZED IRON BUILDINGS

IRON & STEEL TANKS, CISTERNS, DOORS, SASHES, CHIMNEYS.

# JOHN LYSAGHT, Limited.

Bristol, Newport (Mon.), London.

CHIEF OFFICES: ST. VINCENT'S IRONWORKS, BRISTOL.

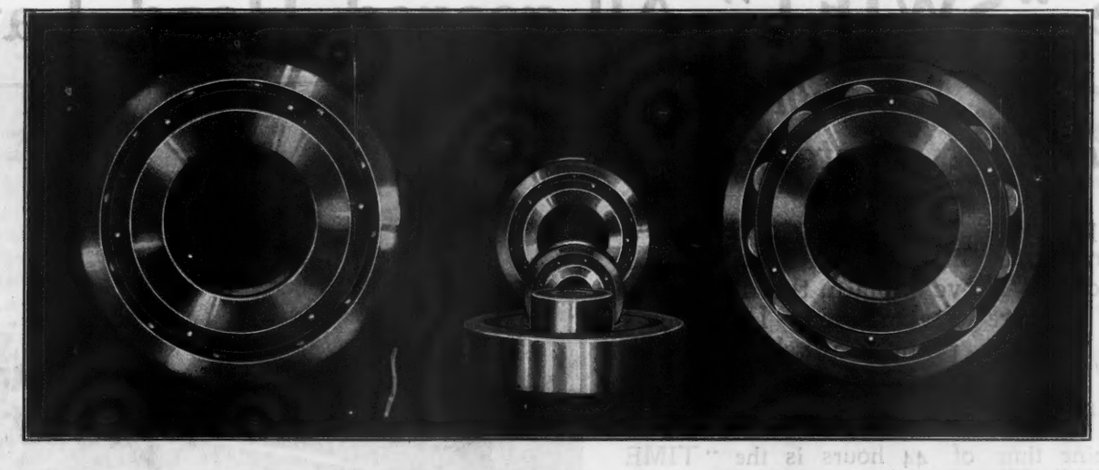


LONDON OFFICES: IMRIE HOUSE, 33-36, KING WILLIAM STREET, E.C. 4.

1715

Platers' Shed for Shipyard, designed and constructed by us.

BRIDGES. GIRDERS. ROOFS. BUILDINGS.



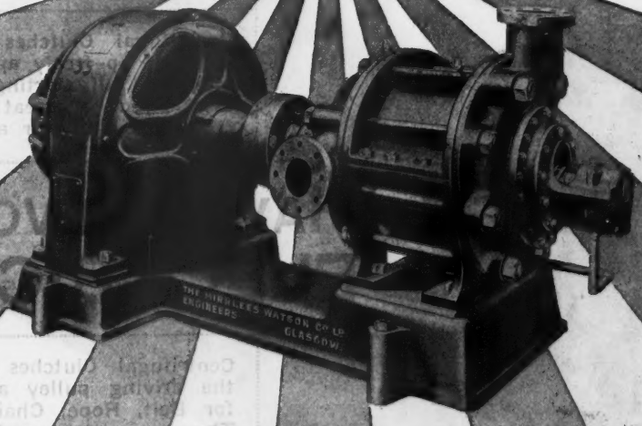
# HOFFMANN BALL & ROLLER BEARINGS

Made for Engineers
by Engineers

4815

THE HOFFMANN MANUFACTURING CO., LTD. CHELMSFORD, ESSEX.

# TURBINE MIRRLEES PUMPS



Makers of Centrifugal Pumps for all purposes

The MIRRLEES WATSON COMPANY LIMITED
ENGINEERS GLASGOW

High Vacuum Extraction Pumps for Surface Condensers

1690

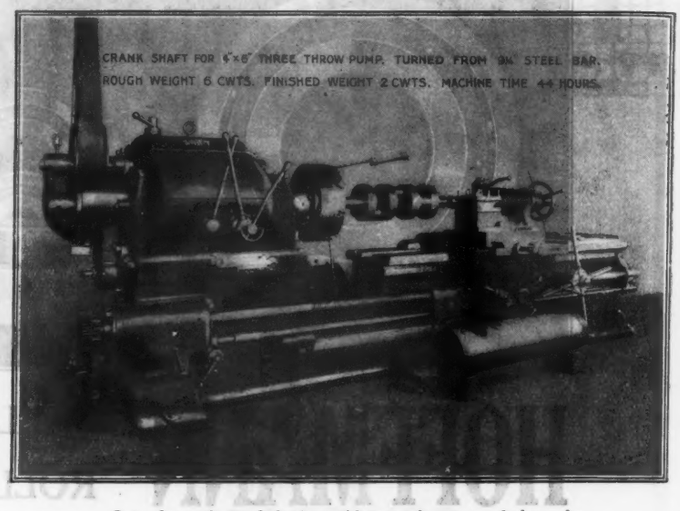
E

# The "SWIFT" All-geared Head Lathe

## *does the job efficiently and without waste of time*

THIS photo has been sent to us by the users of the machine illustrated. As the particulars above explain, the machine—our 12½" Centre Geared Head Lathe—has turned a 3-throw, pump crankshaft from a solid 9¼" steel bar similar to that in front of machine.

The machine time of 44 hours is the "TIME ALLOWED." These cranks, however, have been done in 35 hours—and 120 of them have been turned without the machine giving any trouble whatever. The machine deals with the job without any jar or chatter, and its duty is as severe as any Lathe can be put to. It is the only Lathe in a large works that will do this job satisfactorily.


CRANK SHAFT FOR 6"×6" THREE THROW PUMP. TURNED FROM 9¼" STEEL BAR.
ROUGH WEIGHT 6 CWTS. FINISHED WEIGHT 2 CWTS. MACHINE TIME 44 HOURS.

*Let these facts help to guide you in your choice of a machine—for, whatever the job you have to do, we can offer you a suitable machine that will ensure maximum output.*

***Please send your enquiries to:—***

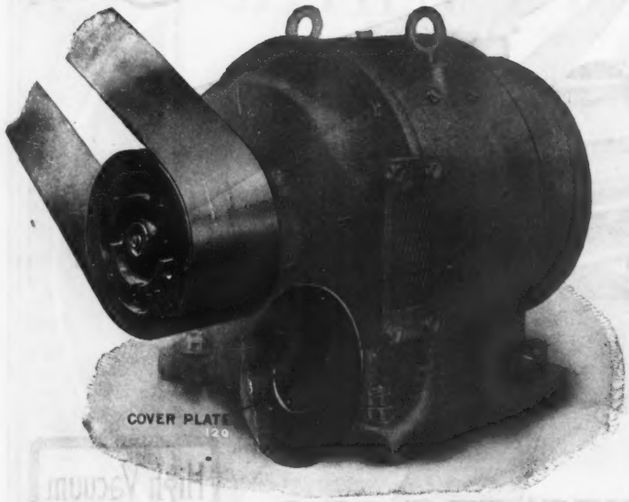
## GEORGE SWIFT & SONS, LTD.,

**CLAREMONT IRON WORKS, HALIFAX, ENGLAND**

'Phone: 497 HALIFAX. 'Grams: "SWIFTLY, HALIFAX."

## "Broadbent"

# CENTRIFUGAL CLUTCHES




**Centrifugal Clutches enable the Motor to start up freely against full load and eliminate all starting difficulties. They also effect a great saving in cost of Switchgear and Current.**

## HAVE REVOLUTIONISED ELECTRIC DRIVING

**Centrifugal Clutches are combined with the driving pulley and can be adapted for Belt, Rope, Chain, or Gear Drives. They are also made in the form of Couplings for direct-driven machinery.**

## THOMAS BROADBENT & SONS, LIMITED,

**ENGINEERS - - - HUDDERSFIELD.**

***Write for Fully Illustrated Catalogue—Post Free.***

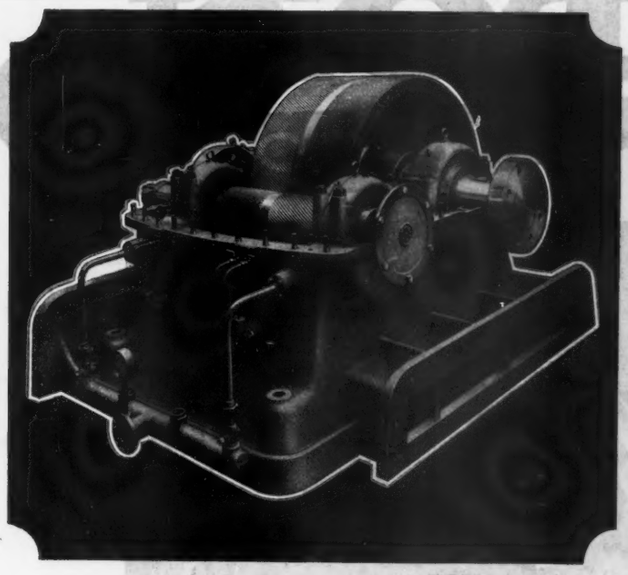


*Illustration shows DBS TURBINE GEAR, fitted with Michell Journal Bearings, driving a Paper Mill —2700 HP. reducing from 3600 to 428 R.P.M.*

# ACCURATE GEARS

**ECONOMY in power transmission is directly affected by the efficiency of its working medium, and our long experience in the application and manufacture of gearing of every form, enables us to offer you numerous advantages both in quality and design.**

*DBS GEARS ARE GENERATED BY IMPROVED METHODS AND CAN BE FOUND CONTROLLING POWER TRANSMISSION IN EVERY INDUSTRY.*

## DAVID BROWN & SONS (HUDD.) LIMITED,

Gear Specialists, LOCKWOOD.

*Send for our New Treatise:* "MACHINE CUT GEARING."

Park Gear Works, HUDDERSFIELD

994

THE GLOBE PNEUMATIC ENGINEERING COMPANY LIMITED

1, VICTORIA STREET, LONDON, S.W. 1.

## "G.P.E." PNEUMATIC TOOLS

— BRITISH MADE THROUGHOUT —

CHIPPING, CAULKING AND RIVETING HAMMERS. DRILLING, REAMING AND TAPPING MACHINES. YOKE, JAM AND SHELL RIVETERS. SAND RAMMERS, RIDDLERS AND FOUNDRY PLANT. CORNER DRILLING MACHINES, SURFACE GRINDERS, WIRE BRUSHES AND AIR MOTORS, AIR COMPRESSORS AND COMPLETE PNEUMATIC PLANT.

O8611

**BRANCH OFFICES AND AGENCIES.**

GREAT BRITAIN.

THE GLOBE PNEUMATIC ENGINEERING CO., Ltd.
-34, Grainger Street West, Newcastle-on-Tyne.
F. WOLFF & CO., Ltd.—Sanctuary House, Tothill Street, Westminster, S.W. 1. (London and Southern District.)
ALEX. A. EDMISTON & CO.—Clydebank Works, Rutherglen, Scotland.
D. WOOD, Esq., M.I.M.E. — 27, State Insurance Buildings, 4, Dale Street, Liverpool. (Liverpool and North Wales District.) JAMES TURNBULL & CO.—3, New Street, Birmingham. GASKELL, WALKER & CO. —Standard Buildings, City Square, Leeds. (Manchester District and Yorkshire.)

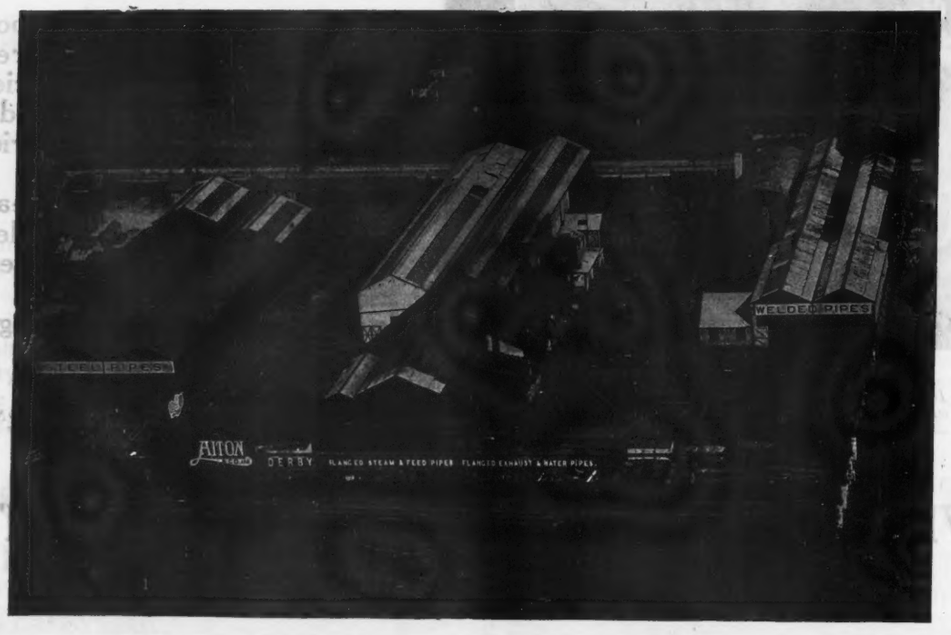
BRITISH DOMINIONS.

Canada and Newfoundland.—CANADIAN ALLIS-CHALMERS Ltd., Toronto. Australia.—GIBSON BATTLE & CO., Ltd., Kent Street, Sydney. New Zealand.—TEAGLE SMITH & SONS, Ltd., 276-278, Wakefield Street, Wellington, N.Z. British West Indies.—HERBERT G. W. BRINSLEY, Port of Spain, Trinidad. India.—JOHN E. MINNITT, Ltd., Bombay.

FOREIGN.

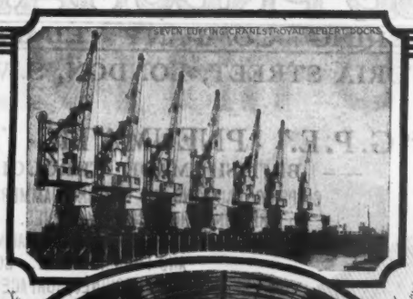
United States of America.—CANADIAN ALLIS-CHALMERS, Ltd., Toronto. France, Belgium and Spain.—STE. AN. LES OUTILS PNEUMATIQUES GLOBE, 58, Rue des Mathurins (8e), Paris. Norway.—TEKNISK CO., Dronningensgt 14, Christiania. Denmark and Sweden.—FRANTS ALLING, Puggaardsgade 4, Copenhagen. Japan.—Dr. T. SHIN, 1, Mitsu Bishi Building, 1, Yayesucho Ichome, Kojimach Ku, Tokyo. Siam.—Messrs. SIAM ARCHITECTS (Import) LTD., Bangkok. Argentine.—ANDERSON, LEVANTI & CIA., 471, Calle Alsina, Buenos Ayres.

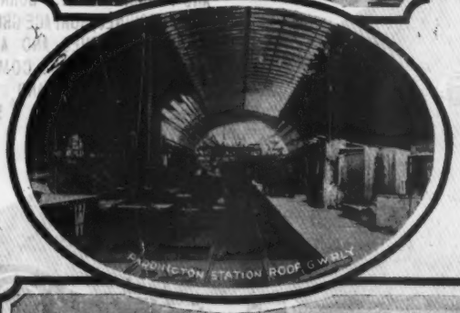
# AITON & CO. LTD.
DERBY.




1673

# HORSELEY Achievements have aided the prosperity of Britain.






THE Nineteenth Century saw great progress in engineering in Great Britain, which marked the introduction of mechanical power. Our contribution included the first iron steamboat, early locomotives, bridges, gas holders, etc., and to-day many landmarks exist in the form of constructional work built by the Horseley Company.

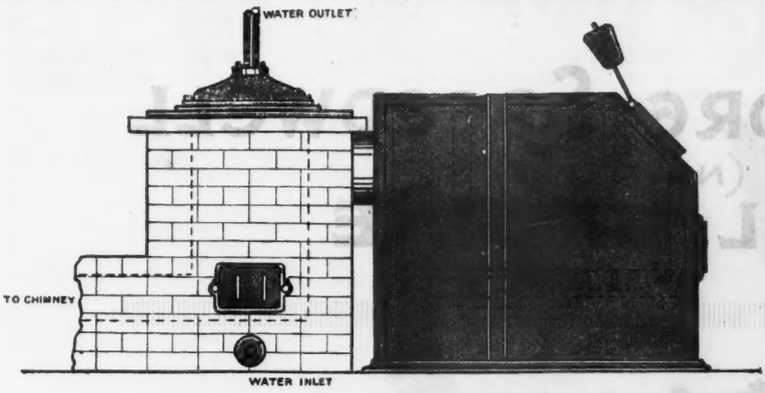
We thus have a very rich experience to draw upon, and our knowledge, based as it is on a record of progressive ideas, is placed freely at the disposal of our customers.

*ASK HORSELEY TO QUOTE FOR CONSTRUCTIONAL WORK OF EVERY DESCRIPTION.*

## THE HORSELEY BRIDGE AND ENGINEERING CO. LTD
CONSTRUCTIONAL ENGINEERS AND IRONFOUNDERS
HEAD OFFICE AND WORKS TIPTON, STAFFORDSHIRE.

1261

# MELDRUMS LIMITED




## WORKSHOP HEATING FROM INDUSTRIAL REFUSE BY MEANS OF THE "MELDRUM" REFUSE DESTRUCTOR AND WATER HEATER.

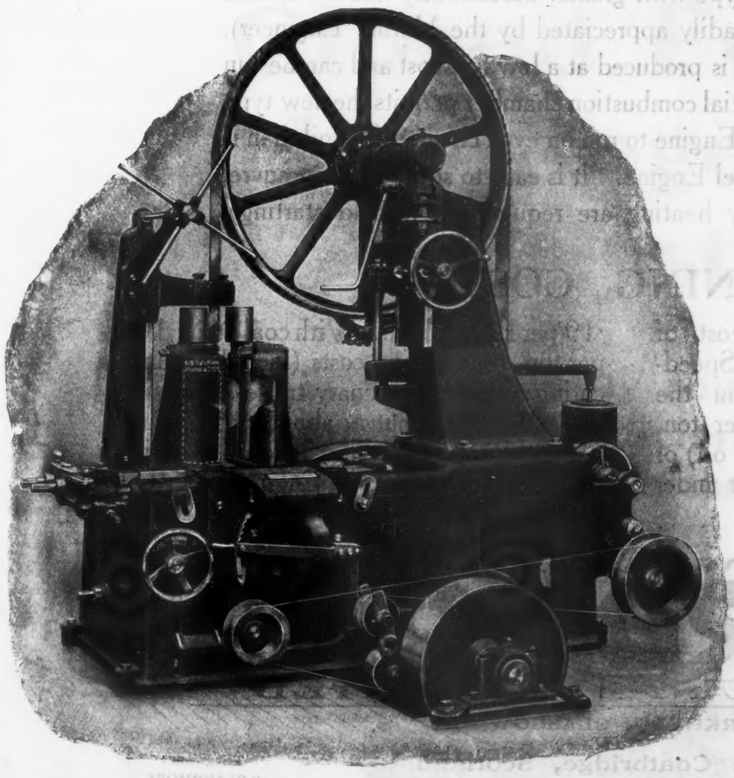
## REAL TANGIBLE ECONOMY.

Live steam — using Coal — is an expensive means of Works Heating — but a "Meldrum" Destructor will efficiently transform waste into useful heat for that purpose at practically no cost. Any waste from dry paper and sawdust to wet spent tan, hops, fruit pulp, etc. Many and varied are the industries to which we have applied our experience — one Tannery consumes 120 tons per week of wet spent tan and tan-pit refuse and heats a Lancashire Boiler; another Tannery uses 20 tons per day of Myrabolums and Mimosa Bark and heats a Babcock Water Tube Boiler; a big Shipyard burns 40 tons per 24 hours and so raises all the steam required in its Smithy; another big Shipyard burns 50 tons per day, and so on; WRITE US—WE MAY BE ABLE TO GIVE YOU A SIMILAR SAVING. Ask for List 106 D and tell us just what waste you have for disposal. Small quantities may have possibilities. 7283

*Ask for List No.* 106 D. *or above;* 106 F. *and* S. *on Forced Draught and Mechanical Stokers;* 106 C. *on Chemical Plant.*

***Branch Offices :***— **LONDON:** 108, Victoria St., S.W. 1. **GLASGOW:** 170, Hope St. **NEWCASTLE:** 59, Side. **CARDIFF:** 30, Charles St.

# TIMPERLEY nr. MANCHESTER



## VERTICAL BAND RE-SAW

**FOR SELF-CENTRING AND DEEP CUTTING WIDE BOARDS.**
**Type PH.**

**Roller Feed Arrangement And Canting Adjustment**

**Quick Acting Variable Feed**

**Patent Ball Bearing Mounting of Saw Pulleys**

**Sensitive Straining Device**

**Repeat Orders for four of these machines** have been received from an important **English Saw Mill.**

WRITE FOR LEAFLET "E 79."

1508

# THOS. ROBINSON & SON, Ltd., ROCHDALE.

**LONDON OFFICE: Abbey House, 2, Victoria Street, Westminster, S.W. 1.**

# BEARDMORE SPEEDWELL
## (NEW TYPE)
# OIL ENGINE

This Beardmore Speedwell Oil Engine (new type) approximates in efficiency the Diesel Engine but the design embodies the simplicity of the so-called Semi-Diesel type with greater accessibility and robustness (features which will be readily appreciated by the Marine Engineer). This new type Oil Engine is produced at a low first cost and can be run by ordinary labour. A special combustion chamber permits the new type Beardmore Speedwell Oil Engine to run on even cheaper fuel oil than is used for the ordinary Diesel Engine. It is easy to start and manœuvre, no lamps for preliminary heating are required, i.e. (cold starting).

## RUNNING COSTS.

Some idea of the comparative cost of running the new type Beardmore Speedwell Oil Engine is gained from the following. With fuel oil at £3 per ton, running costs (including lubricating oil) of the Beardmore engine works out at under ·19 per B.HP. hour. With coal at £1 10s. per ton, the running costs (including lubricating oil) of an ordinary triple expansion steam set works out at about ·385 pence per B.HP. hour. This shows a saving in favour of the Oil Engine of 50%.

WILLIAM
# BEARDMORE
AND COMPANY LIMITED

PARKHEAD, GLASGOW.

Telephone: 360 VICTORIA.

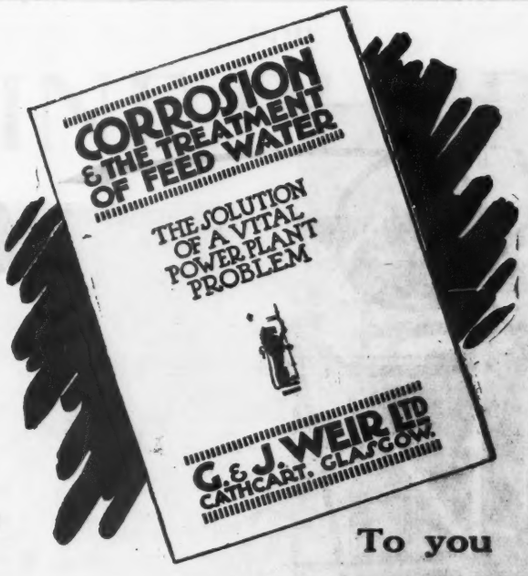
**Works: Coatbridge, Scotland.**

*London Office: 38, Victoria St., S.W.1.*

All inquiries to be sent to Speedwell Works, Coatbridge.

Telegrams: "BEARDMORE, SOWEST, LONDON."

1109




To you
on request,

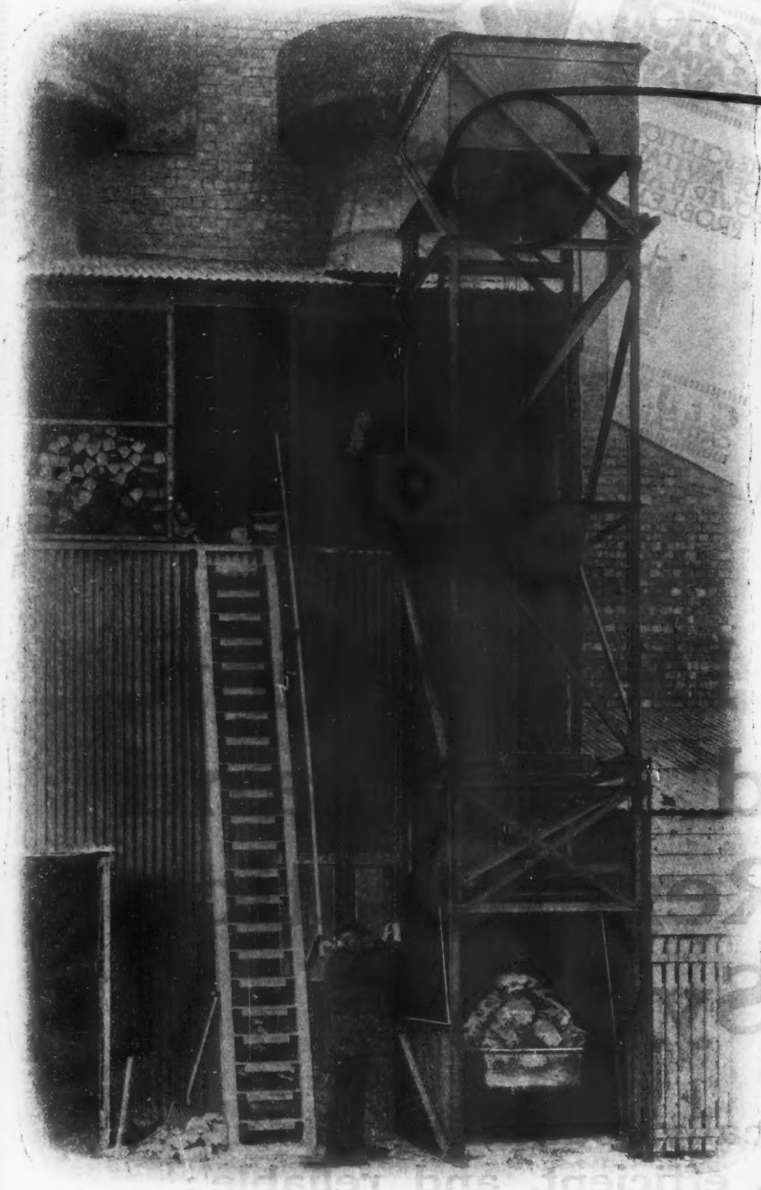
# The WEIR De-aeration, Closed Feed, and Heat Regeneration System

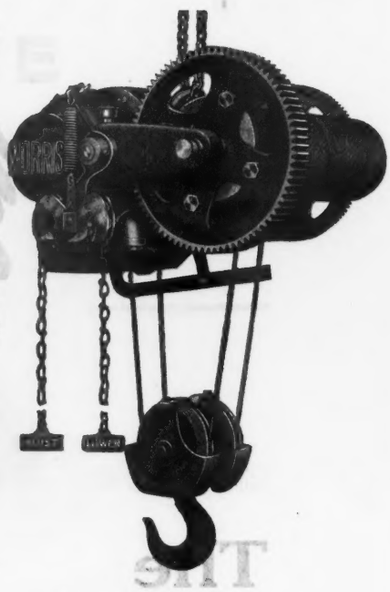
**is scientifically sound; its units are well-made, efficient, and reliable; its results are reflected in improved performance and saving in maintenance and attention.**

G. & J. WEIR, LTD.
CATHCART : GLASGOW

1130

# MORRIS ELECTRIC HOIST-BLOCKS






## POST-WAR HOISTS AT PRE-WAR PRICES

There is no need to ask for a quotation. The net selling prices, which include suitable packing and delivery F.O.R. any goods station (inland or port) in Gt Britain, are as follows:-

| Working Load | | ½ Ton | 1 Ton | 2 Tons | 3 Tons | 5 Tons |
|---|---|---|---|---|---|---|
| Tested to | | ¾ Ton | 1½ Tons | 3 Tons | 4½ Tons | 7½ Tons |
| Prices | Direct Current 100-110 Volts | £69 Wyzeb | £89 Wyzic | £102 Wyzod | £145 Wyzuf | £188 Wyzza |
| | Direct Current 200-550 Volts | £60 Yaacs | £80 Yaact | £90 Yair | £130 Yakhd | £170 Yaril |
| | Alternating Current (2 or 3 Phase) 220-600 Volts | £69 Yaadt | £89 Yaapy | £102 Yajar | £145 Yamig | £188 Yarja |
| Hoisting Speeds F.P.M. | | 22 | 20 | 20 | 18 | 15 |
| Clear Height of Lift | | 20ft. | 20ft. | 20ft. | 20ft. | 20ft. |

Send for Book M 281 illustrating other types of Morris Hoists.

# MORRIS HOISTS

HERBERT MORRIS, LTD., LOUGHBOROUGH, ENGLAND.

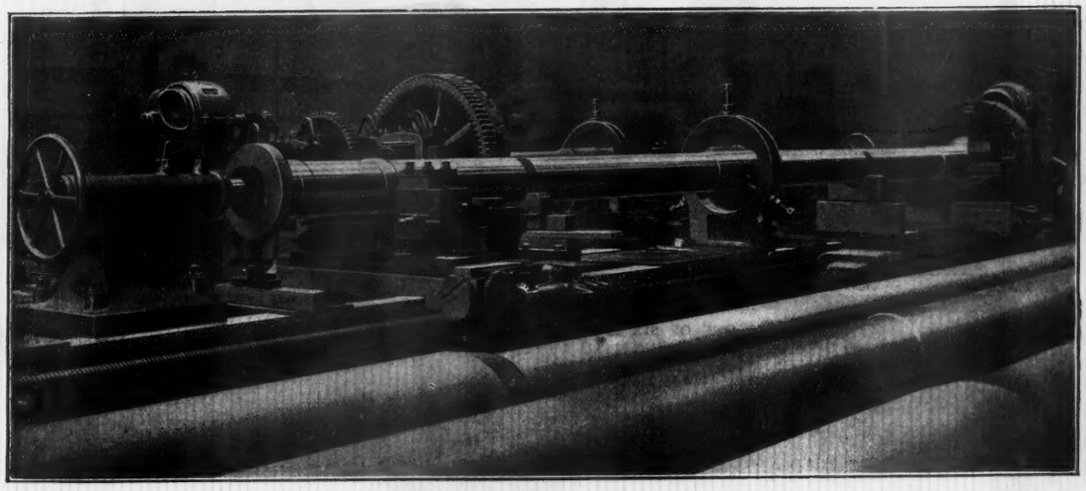
1813

D 1

# STEEL FORGINGS
FOR
# MARINE PURPOSES

3-THROW CRANK SHAFT.

| | |
|---|---|
| Diameter of Shaft | 13½ in. |
| Diameter of Pins | 14 in. |
| Stroke | 4 ft. |
| Total Length | 21 ft. |
| Finished Weight | 12 tons 10 cwts. |



INTERMEDIATE SHAFT.

| | |
|---|---|
| Diameter of Shaft | 12¼ in. to 14¾ in. |
| Total Length | 54 ft. 2⅜ in. |
| Diameter of Bore | 7½ in. |
| Finished Weight | 7 tons 15 cwts. |

## THOS. FIRTH & SONS, LTD.,
## SHEFFIELD.

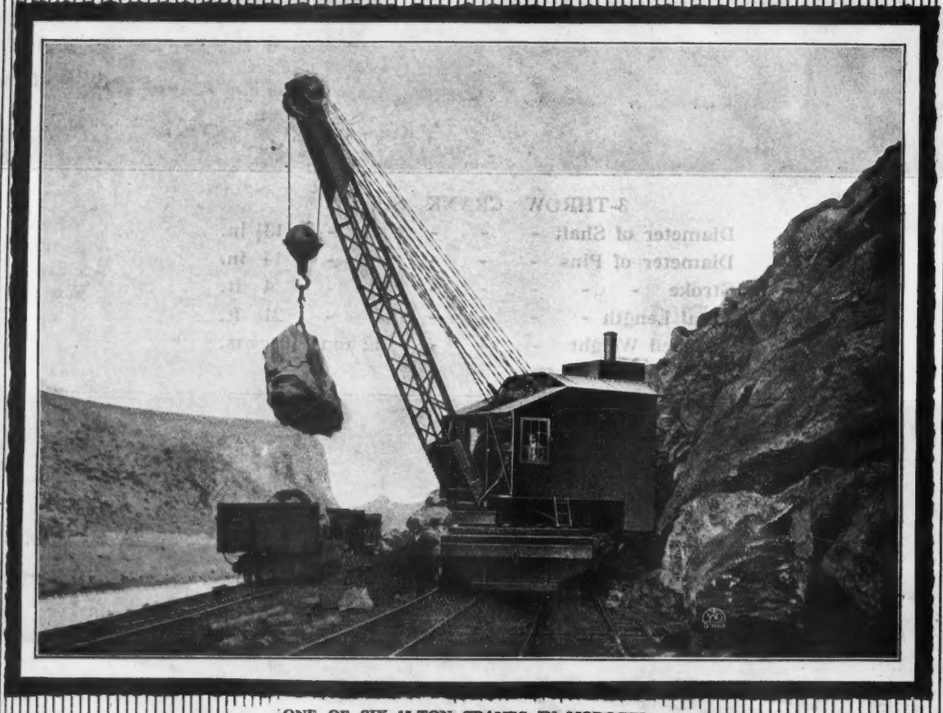
1141

We are exhibiting at the Empire Exhibition, Wembley, April to October, 1924,
Stand No. 8, Avenue Nos. 7 and 8, Bay Nos. 21/22, General Engineering Section.

SPECIAL STEAM

# CRANES

FOR CONSTRUCTIONAL WORK



ONE OF SIX 15-TON CRANES IN MOROCCO.

# STOTHERT & PITT

LIMITED

# BATH, ENGLAND.

# ROYLES LIMITED, IRLAM, NR. MANCHESTER.

## FEED WATER HEATERS
**ROW'S PATENT**
**Exhaust Steam Type**

For UTILIZING *EXHAUST* Steam and imparting a high temperature to Boiler Feed and *SAVING*
— from —
**15% to 20% OF FUEL.**

**Saves the Boiler from Strains and Eases the Firing.**

*Made in many sizes.*

## FEED WATER HEATERS
**ROW'S PATENT**
**Live Steam Pattern**

This Heater has been extensively adopted in the **Marine and might with advantage be more generally adopted in land practice.**

There is undoubtedly an economy of fuel in heating feed water by live steam and the practice saves the Boiler from destructive strains When used in connection with economisers on land plant saves the wasting of the economiser tubes.

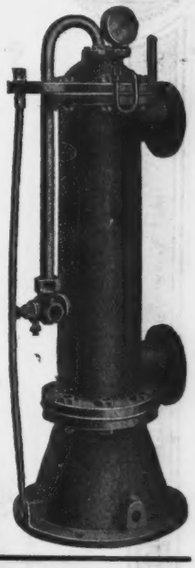
**Suitable for the Highest Pressures.**

***Made to pass Board of Trade and Lloyd's.***

## CALORIFIERS
**ROW'S PATENT**
**Standard Pattern**

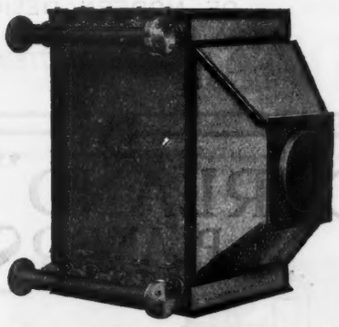
For heating water by steam for circulating through pipes, radiators, &c., for the direct or indirect heating of buildings, also heating water for manufacturing purposes such as bleaching or dyeing house, tanneries, and many other branches of industry, or for heating water in public baths or other establishments. Land or Ships' use.

**With or without Auto Steam Control.**



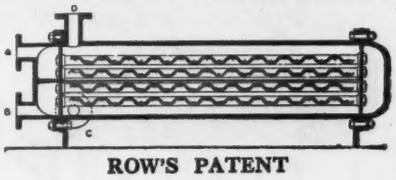
## AIR HEATERS
**ROW'S PATENT**

FOR — DRYING — FABRICS — GRAIN,
All classes of Goods.
Also Heating of large Buildings, etc., etc.
No conflict between Steam and Condense.



***Duties and Prices on Application.***

## OIL HEATERS & COOLERS



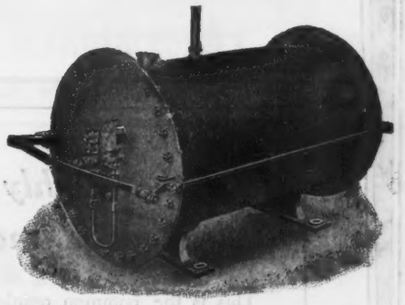
**ROW'S PATENT**

**FOR HEATING FUEL and VEGETABLE OILS**
**TO HIGH TEMPERATURES**
**ALSO FOR**
**COOLING LUBRICATING OILS**
**HIGHLY EFFICIENT AND RELIABLE**

## STORAGE CALORIFIER
**ROW'S PATENT**

The Calorifier holds, heats, and automatically controls the temperature of a large quantity of water. Made in several sizes in either mild steel or copper. The tubes with cover can be withdrawn, the opening giving access for any deposit to be cleared out.

***For Land or Marine Service.***



## BOILING BATTERY
**ROW'S PATENT**
**Fit in your Existing Tanks**

**For Tanneries, Dye Works, Paper Works, Bleach Works, Breweries, &c.**

For many industrial operations Coils or Worms of Pipe are used, and it is not generally known that the efficiency of a Coil is limited by its length.

## BATH WATER HEATER
**ROW'S PATENT**
**Instantaneous**

For Bath or Lavatory Basin. Heats the water as it runs through. Constructed entirely of Gun Metal and Copper or Casing Enamelled Iron. No pressure on the water side, and suitable for the highest steam pressures.

**VERY SUCCESSFULLY USED IN MARINE PRACTICE.** 1599

## STEAM KETTLES
**ROW'S PATENT**
**For Quick Boiling**

For supplying Hot Water for Hotels, Clubs and Public Institutions, also extensively used for Works, Mills, &c., for supplying workmen's cans, &c., and wherever a copious supply of Boiling Water is desired derived from Steam.

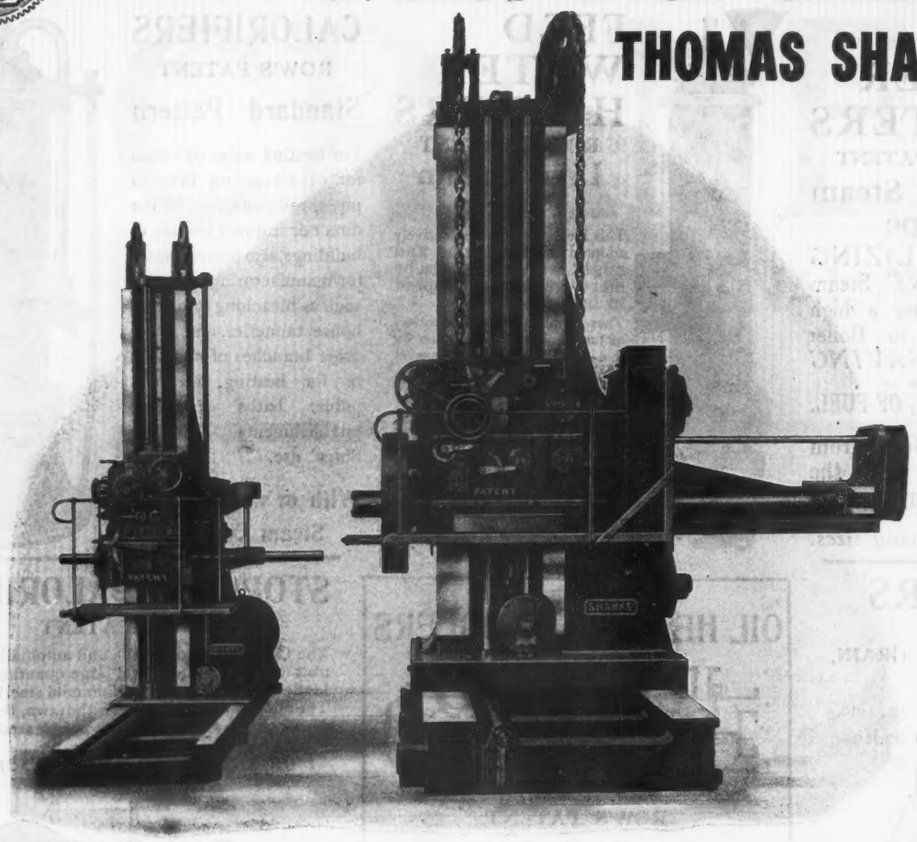
The Kettle is made of copper and all surfaces in contact with the water are coated with pure tin.

**¶ Made in many sizes from 3 galls. upwards.**

# ASSOCIATED BRITISH MACHINE

17, GROSVENOR GARDENS

MANCHESTER - LEEDS - GLASGOW - BIRMINGHAM



4 in. Spindle. 10 in. Spindle.

## THOMAS SHANKS & CO., LTD.,
JOHNSTONE,
near GLASGOW.

**MAKERS OF MACHINES**
FOR
BORING,
TURNING,
PLANING,
DRILLING &
SLOTTING.

Highest Class Design,
Workmanship & Material.

FOR HIGH-CLASS
HEAVY
**MACHINE TOOLS**
OF MODERN DESIGN.

*ENQUIRIES INVITED.*

***"—thoroughly satisfied with your machines."***

This is the common opinion of "Asquith" users. In actual service "Asquith" Drilling Machines prove their unique quality and reliability. The best endorsement of this quality is the fact of the many endeavours at imitations, which can never hope to equal the standard of "Asquith" designs.

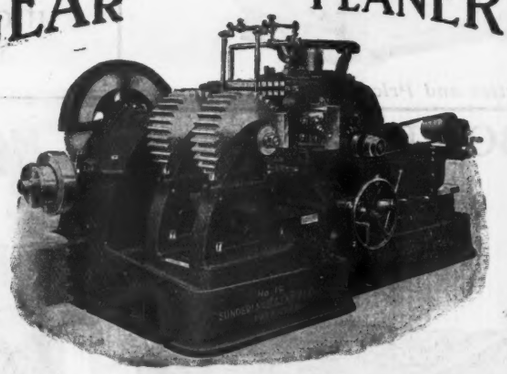
**ASQUITH**

The Asquith" way increases production and reduces costs. We ask for an opportunity to prove this to you. Submit your problems to us without obligation.

1441

WM. ASQUITH (1920) LTD.
*Park Works, Halifax, Eng.*

"SUNDERLAND"
GEAR PLANERS



J. PARKINSON & SON,
SHIPLEY, ENGLAND.

**TO READERS IN INDIA!**

We hold a most comprehensive stock of machine tools and equipment at our Calcutta Branch, where our staff will be glad to see you and advise on any machine tool questions. Send your enquiries therefore to—

**A.B.M.T.M. LTD., Temple Chambers, 6, Old Post Office St., Calcutta.**

Telegrams: "Britoolmak, Calcutta." Telephone: Calcutta 4345.

# TOOL MAKERS LIMITED

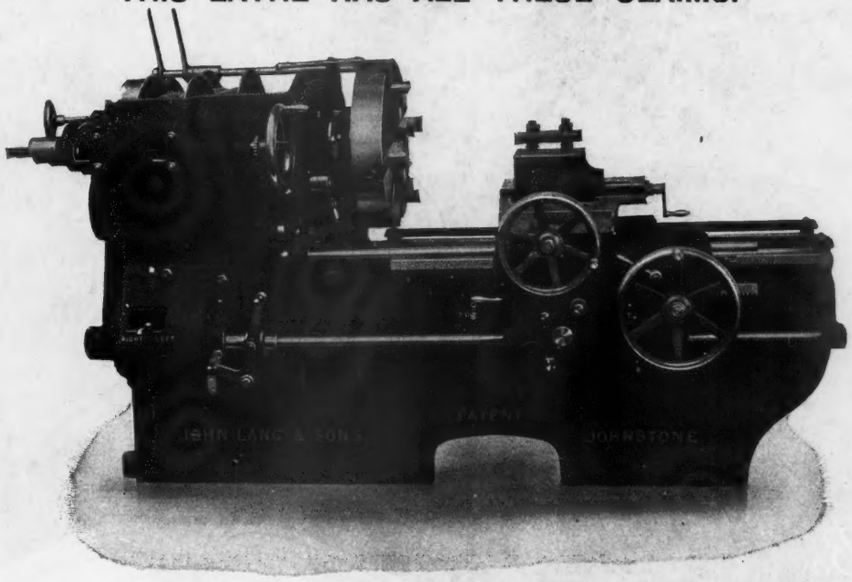
LONDON, S.W.1.

NEWCASTLE - PARIS - BRUSSELS - CALCUTTA

## WHAT IS YOUR OPINION OF A LATHE?

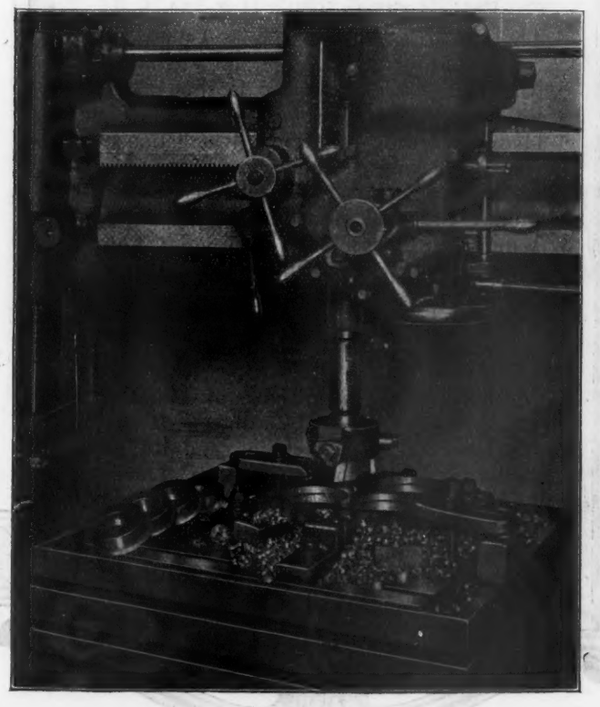
When the spindle speed automatically increases as the tool travels towards the centre.
When the correct speed can be obtained for any diameter.
When the guiding surface of the bed is covered.
When the speed variator is ONE hand-wheel.
When a counter motion is unnecessary.

**THIS LATHE HAS ALL THESE CLAIMS.**



## JOHN LANG & SONS, Ltd., Lathe Manufacturers,

**JOHNSTONE, near GLASGOW.** 1441



## TREPANNING 5 in. HOLES

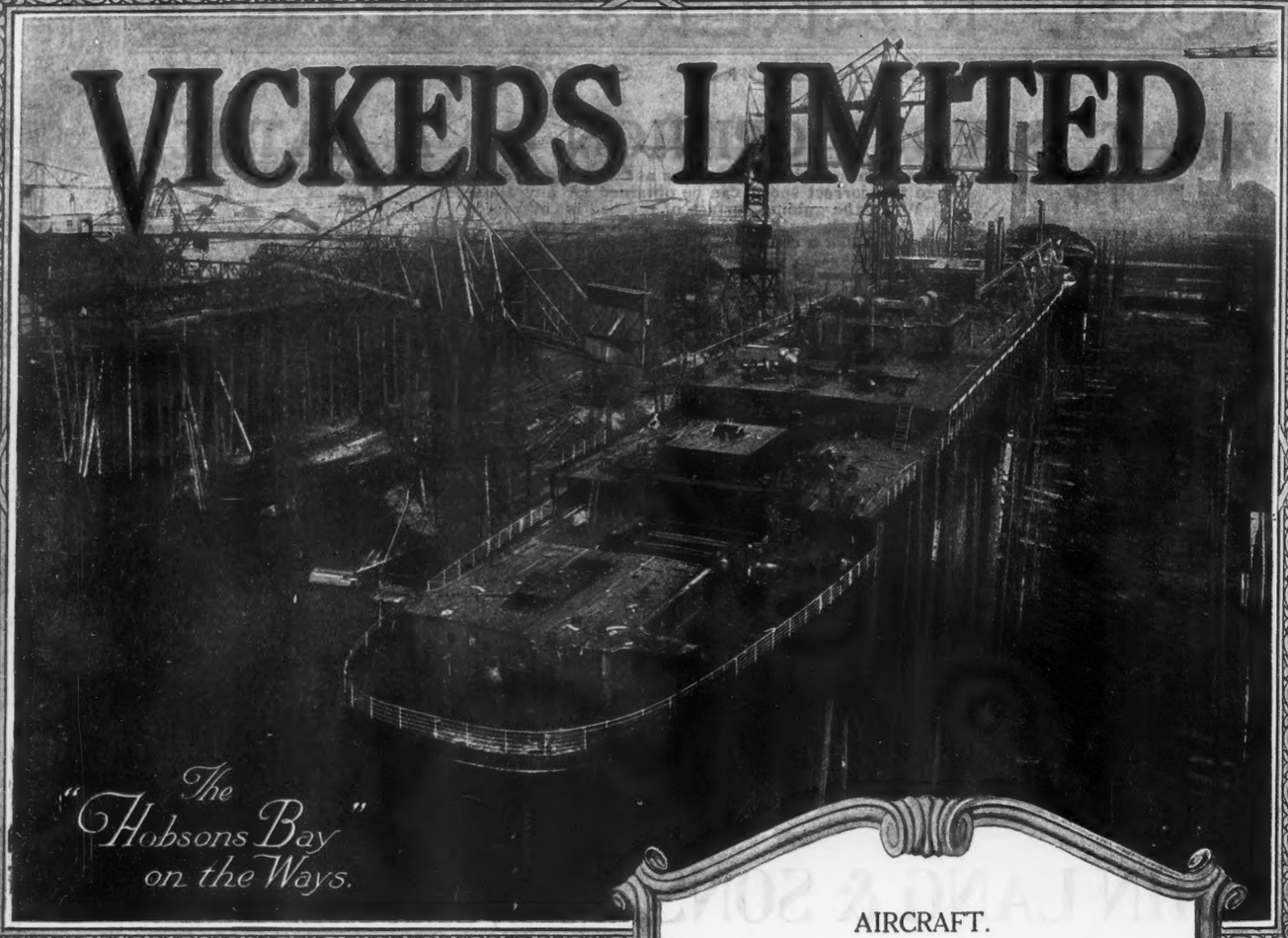
ON AN ARCHDALE 4 ft. RADIAL
(STANDARD PATTERN No. 1250).

*PARTICULARS:*
*DIA. 5 in., DEPTH of HOLE 1⅛ in.*
*PILOT HOLE DRILLED 2 in.*

**TIME 4½ MINUTES.**

## JAS. ARCHDALE & Co.
LTD.,
Ledsam St., BIRMINGHAM.

# VICKERS LIMITED



*The "Hobsons Bay" on the Ways.*

# SHIPBUILDING AND REPAIRS

**Head Office:**

**VICKERS HOUSE, BROADWAY, LONDON, S.W. 1.**

**Works: BARROW-IN-FURNESS, SHEFFIELD, ERITH, CRAYFORD, DARTFORD, WEYBRIDGE.**

**Depots:**

GLASGOW: Vickers House, 247, West George Street.
DUBLIN: 32, Nassau Street.

**Branch Offices:**

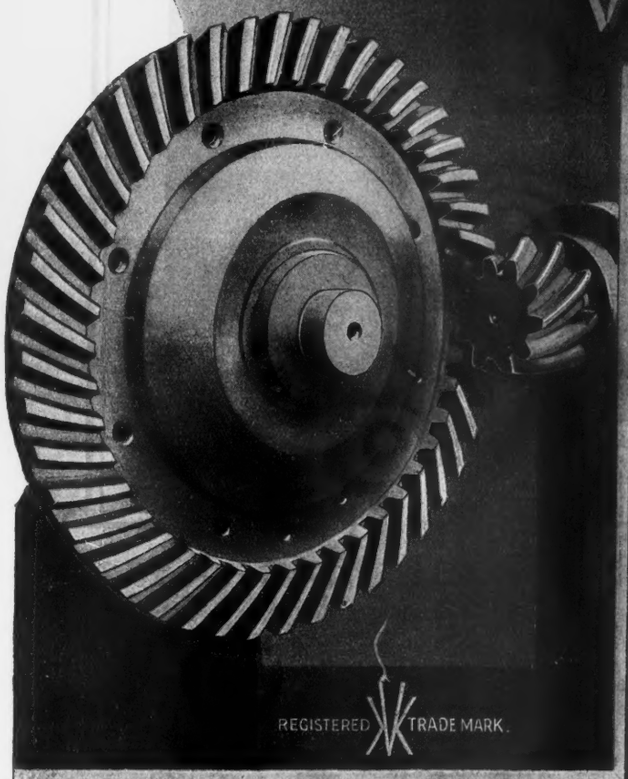
MANCHESTER: Milgate Buildings, Long Milgate.
BRISTOL: 55, Park Street.
NEWCASTLE-ON-TYNE: Commercial Union Buildings, Pilgrim Street.
BIRMINGHAM: Vickers House, Loveday Street.
CARDIFF: Principality Buildings, Queen Street.
LEEDS: Greek Street Chambers, Park Row.
BELFAST: 26a, Arthur Street.

## AIRCRAFT.

Shipbuilding and Repairs. Floating Docks and Cranes. Guns and their Mountings. Armour Plates. Marine Engines of all descriptions, including Turbine and Heavy Oil Engines. Large Gas Engines, 500 to 5000 B.H.P. Michell Thrust Bearings for all purposes. Contraflo Specialities for Ships' Main and Auxiliary Machinery. Contraflo Condensing Plant for Marine and Land Installations. Hydro-Electric Power Installations. Rubber-Making Machinery. Locomotive Boilers and Repairs. Cement-Making and Stone-Crushing Machinery. Electric Winding Engines and Haulages. Oil Well Supplies and Equipment. Drifting Sand Filters for Water Purification. Machine Tools. Engineers' Small Tools, including Vickers' Vanadium High Power Drills and Patent Adjustable Reamers. Machines for the manufacture of Concrete Bricks, Tiles, etc. Cardbox-Making Machinery. Sporting Guns and Rifles. Waterproof Plywood. "Vickers' Duralumin" (*Registered Trade Mark*). Porcelains for all Electrical Purposes. Gas Meters, "Vickcen" Oil Purifiers. Motor Bodies of all types—mass production methods, Etc., Etc.

# Vickers Limited

## SPIRAL & STRAIGHT TOOTHED BEVEL GEAR WHEELS




DROP FORGINGS & STAMPINGS. Vanadium High Speed and other High Grade Tool Steels. Locomotive Crank Axles. Straight Axles for Locomotives, Carriages and Wagons. High Tensile Steel Tyres ("Australia Brand"). Laminated Springs for Railway and Motor Car Use. Motor Car Pressings. Weldless Drawn Tubes in all qualities of Carbon and Alloy Steels. Surface Hardening by Patented Process. Files. Hack Saw Blades. Magnets. Jigs. Gauges. Fixtures. Special Tools. Etc.

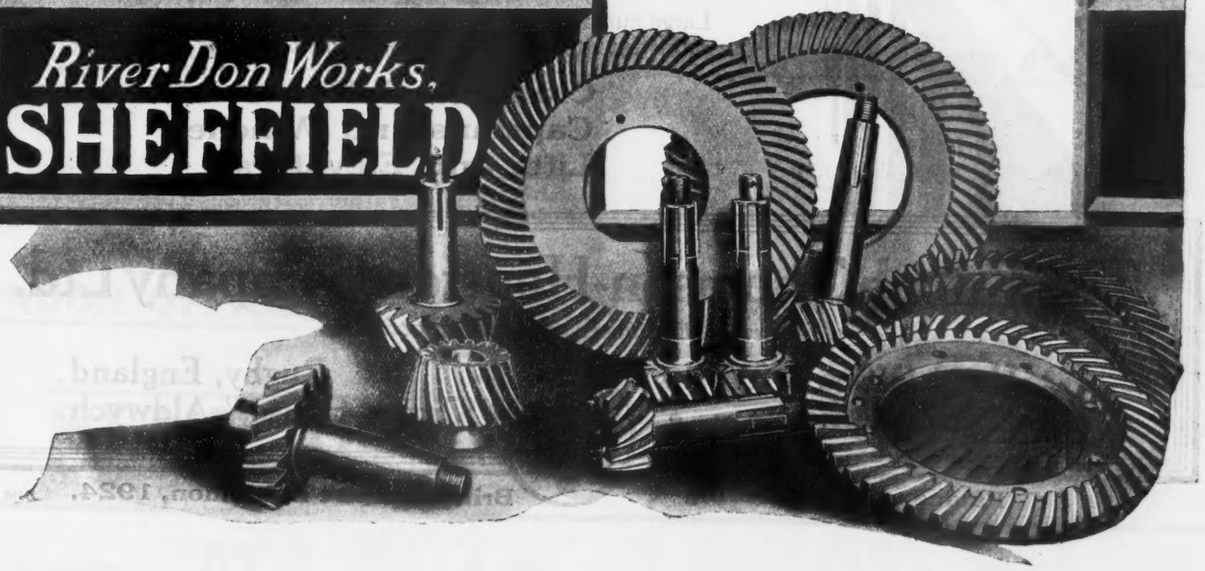
*Head Offices:*

VICKERS HOUSE, BROADWAY, LONDON, S.W. 1.

DEPOTS: Glasgow, Dublin.

BRANCH OFFICES: Newcastle-on-Tyne, Manchester, Birmingham, Leeds, Bristol, Cardiff, Belfast.

*River Don Works,*
**SHEFFIELD**



# Brake Magnets

B.T.H. Brake Magnets, for two and three-phase circuits, are weatherproof and liberally rated, and are fitted with an adjustable air-dashpot which eliminates shock and thereby ensures steady application of the brake.

Large numbers of these brake magnets in constant use prove their consistent and reliable operation in the following services:—

**Cranes and Hoists**
**Capstans and Winches**
**Lifts and Elevators.**

## The British Thomson-Houston Company Ltd.

*Electrical Engineers and Manufacturers*

Head Office & Works ♠ ♠ Rugby, England.
London Office ♠ ♠ "Crown House," Aldwych.

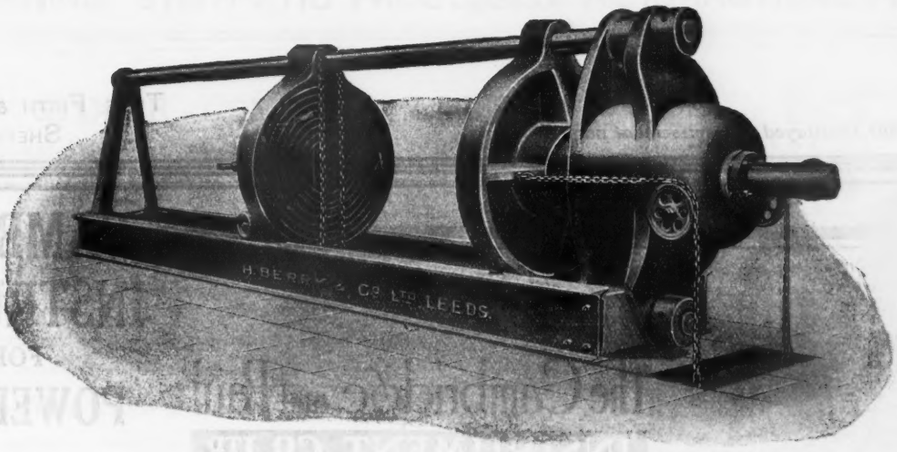
B T-H

Palace of Engineering—— British Empire Exhibition, 1924. 1183

# HENRY BERRY & Co., LTD.,

## LEEDS.

## HYDRAULIC ENGINEERING SPECIALISTS.



**HYDRAULIC PIPE TESTING MACHINES FOR PIPES OF ALL SIZES.**

*TELEGRAMS—RIVETTER, LEEDS.*
*TELEPHONES—20181 & 20182.*

*CODES—A.B.C. 5th Edition,*
*BENTLEY'S.*

**LONDON OFFICE—38, VICTORIA ST., WESTMINSTER, S.W. 1.**

## SEND US YOUR ENQUIRIES.

1094

EMB

STEEL CASE CONTROLLERS

Were designed primarily for Steel Works duty. They are therefore substantially proportioned, readily accessible, and we claim more conservatively rated than any other make. In fact they are the last word in high-class modern design.

THE ELECTRO-MECHANICAL BRAKE Co. Ld.
West Bromwich, England. Established 1908.
Telegrams—Brakes W.B. 'Phone—291 and 292 W.B.

*Brief Specification.*

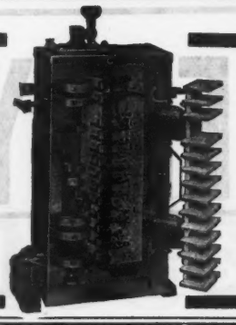
Steel case and steel dust-proof door.

Renewable finger tip and barrel contacts.

Very efficient blowout and robust arc shields.

Complete barrel removable through top of case.

Barrel of unusually large diameter.



1360

O 99

FIRTH'S STAINLESS STEEL

FIRTH STAINLESS

*See our Displayed Advertisement page 37.*

THOS. FIRTH & SONS, LTD., SHEFFIELD. 1148

20

The Cambridge and Paul INSTRUMENT Co Ltd

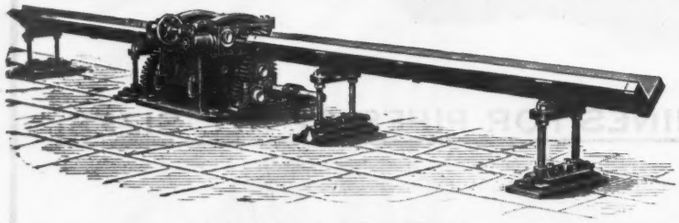
WORKS:- LONDON & CAMBRIDGE. *Head Office & Showrooms* 45, GROSVENOR PLACE LONDON; S.W.1.

CAMBRIDGE INSTRUMENTS FOR THE POWER PLANT.

Many applications for Cambridge Instruments are described in this 28-page List G 906. Let us know if you have not received your copy.

We are exhibiting at the British Empire Exhibition, 1924.

REELING AND STRAIGHTENING MACHINES,



FOR TUBES, BARS, &c.

SAMUEL PLATT, LD., WEDNESBURY.

Agent for France: Mon. FERNAND PERDRIZET, 29-31, Rue de Chabrol, Paris. 8367

Tensile Strength 38 tons.

28% Elongation.

WE HAVE NOT HAD A BROKEN PROPELLER IN 25 YEARS.

MANGANESE AND SILICON COPPER.
PHOSPHOR BRONZE, TIN & COPPER.
ANTI-FRICTION METALS, COPPER AND NICKEL HARDENED.
BABBITTS AND PLASTIC METALS.
CASTINGS ANY SIZE OR WEIGHT.

Telephone:— Potteries 304 (2 lines).

OAK BRAND B N

Telegrams:— "Bronze."

506

BILLINGTON & NEWTON, LTD., LONGPORT, STAFFS.

# HUMPHREYS & GLASGOW, Ltd.,

**38, VICTORIA STREET, LONDON, S.W. 1.**

# HYDROGEN

HIGH PURITY, LOW COST OF PRODUCTION,
LOW COST OF INSTALLATION

## BY NEW PROCESS

9771

FOR OIL HARDENING, SYNTHETIC PROCESSES, AERONAUTICAL PURPOSES, &c.

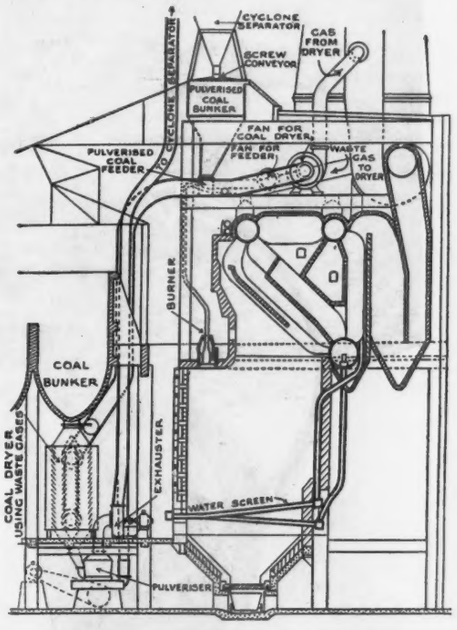
UNDERFEED STOKER COMPANY, LIMITED.

COMBUSTION ENGINEERS.

"LOPULCO" SYSTEM OF PULVERISED FUEL.

*Patent Rights held by Underfeed Stoker Co. for various countries.*

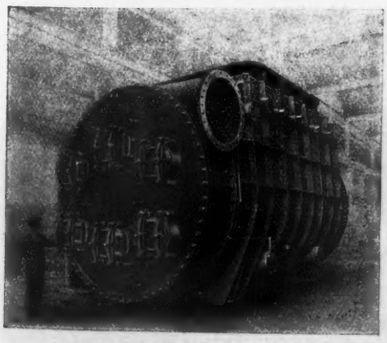
Cross Section of the Vitry Station of the Scé. Anme. Union d'Electricité, Paris, where the system is being installed. There are four boilers, each with a heating surface of 16,678 square feet. Normal Evaporation per boiler per hour from and at 212°F., 140,580 lbs. Maximum Evaporation per boiler per hour from and at 212°F., 210,870 lbs.




ALDWYCH HOUSE, ALDWYCH, LONDON, W.C. 2 WORKS: DERBY.

1478

WHA



"Allen" Surface Condenser.

# CONDENSING PLANT

AND

## AUXILIARIES.

HIGHEST VACUUM — MAXIMUM ECONOMY

WITH

RELIABLE SERVICE.

Built in all sizes up to 25,000 Kw. capacity.

"Compactum" Steam Jet Air Pump.

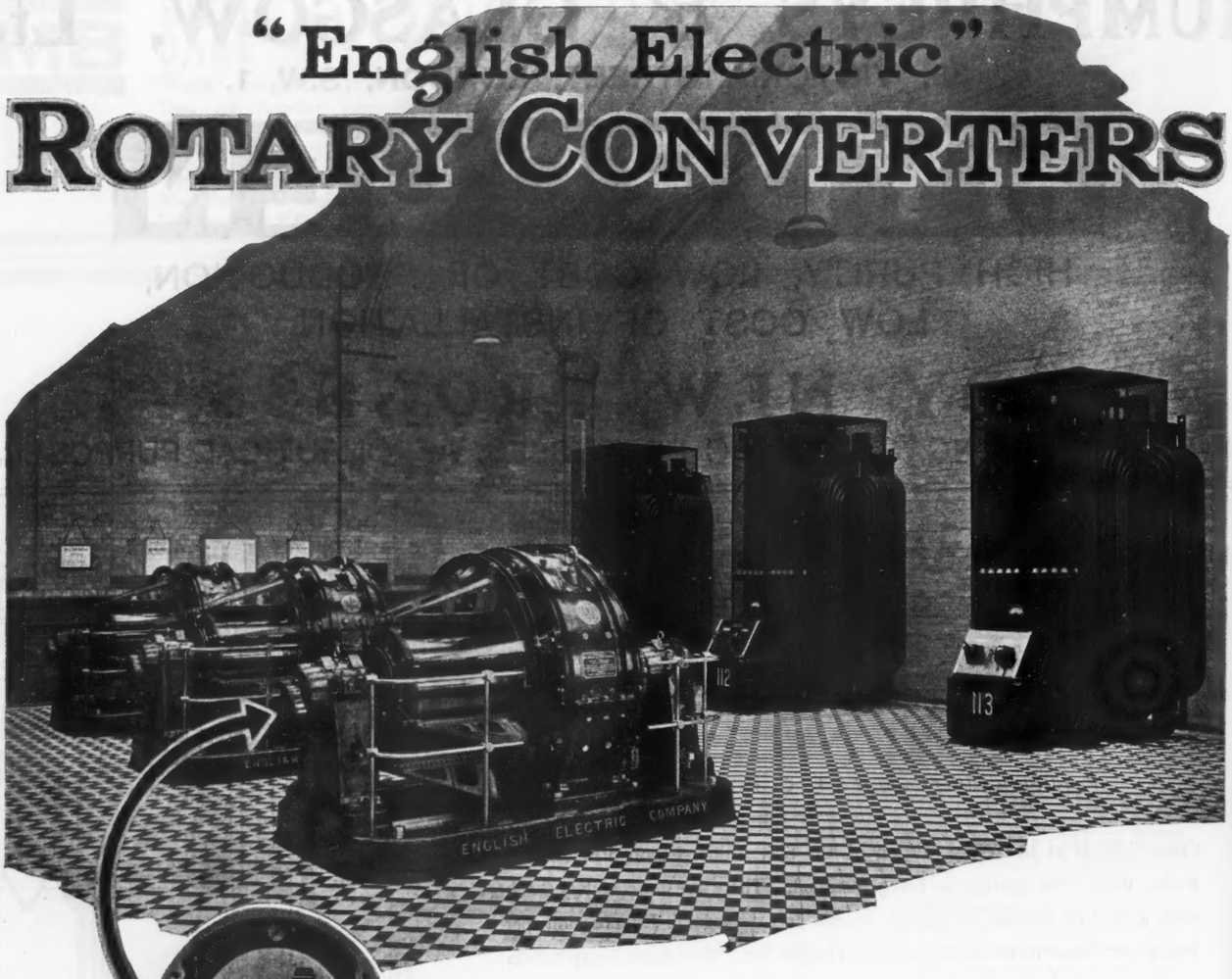
# W. H. ALLEN SONS & CO., LTD.,

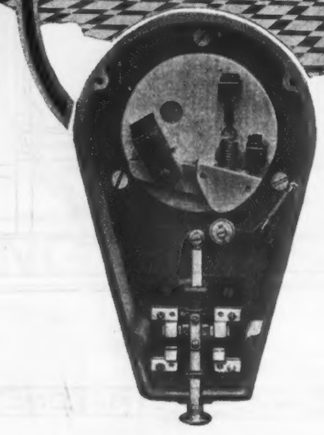
BEDFORD——————ENGLAND.

1560

ALLEN ALLEN

# "English Electric"
# ROTARY CONVERTERS



SPEED LIMITING DEVICE.

THE main illustration shows a Rotary Converter Sub-station in the works of a large Industrial undertaking. The entire electrical equipment was manufactured and installed by The English Electric Company.

In accordance with current practice each Converter is fitted with a Speed Limiting Device which is shown in the foreground with its dust cover removed. All parts of this Device subjected to wear are of hardened steel and the springs are accurately calibrated to ensure absolute reliability.

*Write for Publication No. 396*
*entitled*
*"A Modern Rotary Converter."*

The
## ENGLISH ELECTRIC
Company Limited.

WORKS:-BRADFORD, COVENTRY, PRESTON, RUGBY, STAFFORD.
HEAD OFFICE:-
Queen's House, Kingsway, London, W.C.2.

Rotary Converter Advert. Series, No. 4.

# SMALL FORGING PRESSES

are worthy of the serious attention of all Forge Managers. With their high speed of working and ease and safety of control "DAVY" Forging Presses of small power are very useful forging tools. They are specially suitable for cogging and for forgings of a bulky nature and irregular shape, and

are capable of working up to 120 finishing strokes per minute.

Our Overhung Forging Presses are made in three Standard sizes, *i.e.*—

100 tons power for ingots up to 5 in.
150 " " " " " 6 "
200 " " " " " 8 "

They are self-contained, the interior of the main frame forming the prefiller, and the intensifier being mounted on the back of the frame.

ADVANTAGES.

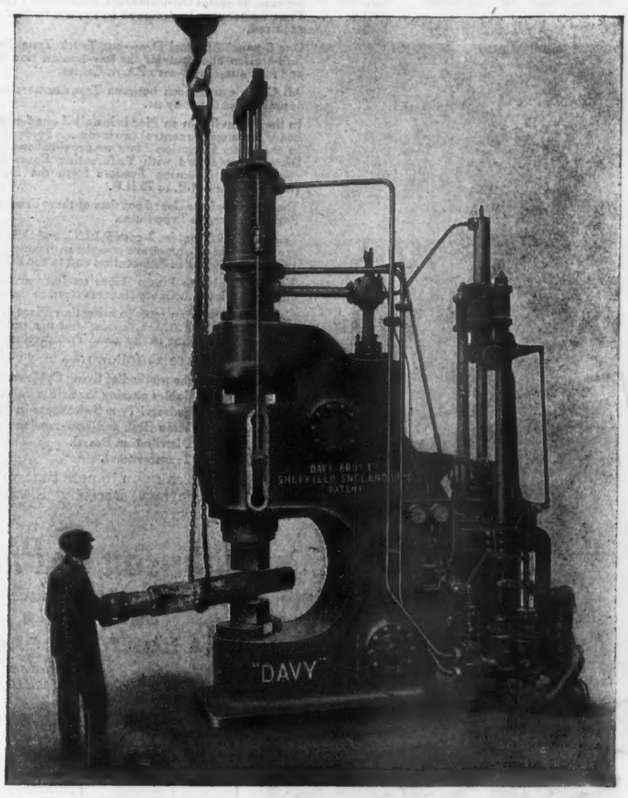
High Speed with absolute control and safety.

Steam consumption much less than that of a hammer for same output.

Absence of noise and shock in working, resulting in less strain to the man handling the work.

Adaptability for forging closely to size irregular pieces which could not be done under a hammer.

Cost of foundations only one-tenth of hammer foundations.




200 tons Overhung Forging Press.

1717

*We also specialise in*

## ROLLING MILLS & STEEL WORKS PLANT

"MORGAN" CONTINUOUS ROLLING MILL PLANTS.

Telephone, 4800 (5 Lines)

DAVY BROS. LTD.
SHEFFIELD.
Estabd 1830.

Telegrams, "MOTOR SHEFFIELD."

# How Electricity is helping Gas.

The days of mutual disparagement are over—the various methods of utilising our coal supplies have settled down into their proper places—all Industries now recognise Electricity as a co-operator, not a competitor.

Here is an example of mutual assistance—some pictures and a brief description of a contract which we have recently executed for the erection of SUB-STATION EQUIPMENT DISTRIBUTION MAINS and DISTRIBUTION BOARDS for the GAS LIGHT & COKE CO., LTD., BECKTON, LONDON, E.

**The installation supplies electricity to the Company's Pumping and Water Filtration Plant.**

**Current is supplied by the Woolwich Corporation at 6600 volts, 3-phase, 50 periods, and is controlled by one of our All-steel Draw-out Truck Cubicles.**

**Two E.H.T. Transformer Truck Type Panels line up with the above and each controls a 500 K.V.A. Step-down Transformer.**

**The Transformers at present installed consist of two of our 500 K.V.A., 6600/450 volts, 3-phase, 50 cycles Oil-immersed Self-cooled Type. Sub-station space and the Truck Type Switchgear is designed to permit further Transformers being provided when required.**

**One 6-panel All-steel Draw-out Truck Type Switchboard is also installed in the Sub-station and controls the low-tension side of the two 500 K.V.A. Transformers and four outgoing 3-core P.L.A. Cables.**

**All Cable connections between Transformers and E.H.T. and L.T. Switchgear were supplied and fitted by us.**

**In the Pump Room on Pier is installed one 6-panel Ironclad A1 Pedestal Type Switchboard, arranged to control two incoming Feeders and the supply to four Motor circuits. In the Water Filtration Plant we provided one Cast Iron Triple-pole Wall Mounting Distribution Board with Trifurcating Boxes for P.L.A. Cables, and arranged to control two incoming Feeders from the Sub-station, and eight Motor circuits ranging from 5 H.P. to 70 H.P.**

**The interior of the Board consists of three Enamelled Slate Panels carrying H.O. Type Porcelain Handle Type Fuses.**

**Two in No. 0.20 sq. in. 3-core P.I.L.C. and D.S. Tape Armoured Low-tension Cables are laid solid in stoneware troughs with covers, bridges and bitumen, and connected to the Switchgear in Sub-station and to the Filtration Plant Distribution Board.**

**Similar Cables to Pump Room on Jetty are laid partly in the ground and partly on substantial W.I. Cable Hangers fixed to the Jetty.**

**Cables to Motors on Jetty in Filtration Plant consist of .04, .06, and .10 sq. in. 3-core P.I.L.C. and D.S.T.A. L.T. Cables and are run on cleats to the various Motors and Starters terminating in the usual Trifurcating Boxes.**

Our pictures are as follows:—

**No. 1 shows the method of fixing Cables under Jetty.**
**No. 2 shows Cables passing through a bulkhead on the way to Pump House.**
**No. 3 shows Pedestal Type Switchgear in Pump House.**
**No. 4 shows Main High and-Low-tension Switchboards in Sub-station.**
**No. 5 shows Distribution Board.**
**No. 6 shows Transformers.**

And we would ask you to note that we are always prepared to undertake any contract whereby Electricity can be made to assist industrial progress.

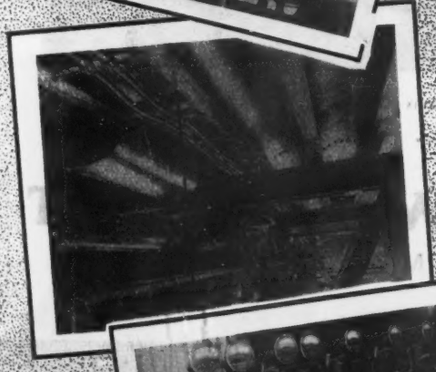
## *Johnson & Phillips, Ltd.,*

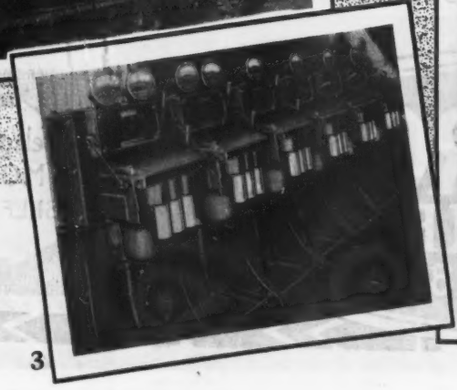
*Specialists in Transmission, Transformation and Distribution of Electricity,*

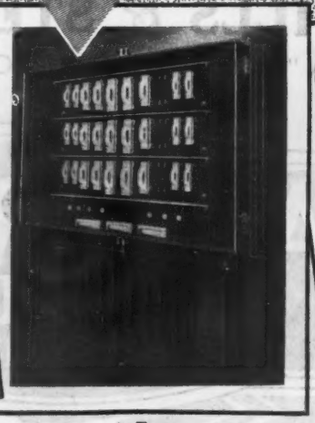
***Charlton, London, S.E. 7.***

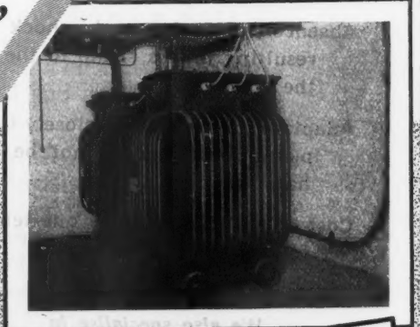
*City Office and Stores:*
*12, Union Court, Old Broad Street, E.C.2.*
*Branches at:*
*Birmingham, Bristol, Cardiff, Glasgow, Liverpool, Manchester. Newcastle-on-Tyne, Portsmouth, Belfast, Sydney (N.S.W.) and at Melbourne.*

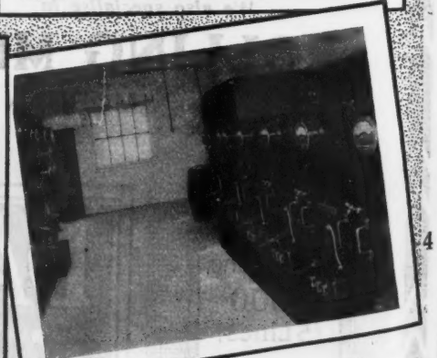
1


2


3


5


6


4

784

# FIAT

## OIL ENGINE DEPARTMENT

STABILIMENTO GRANDI MOTORI
(EX FIAT SAN GIORGIO),

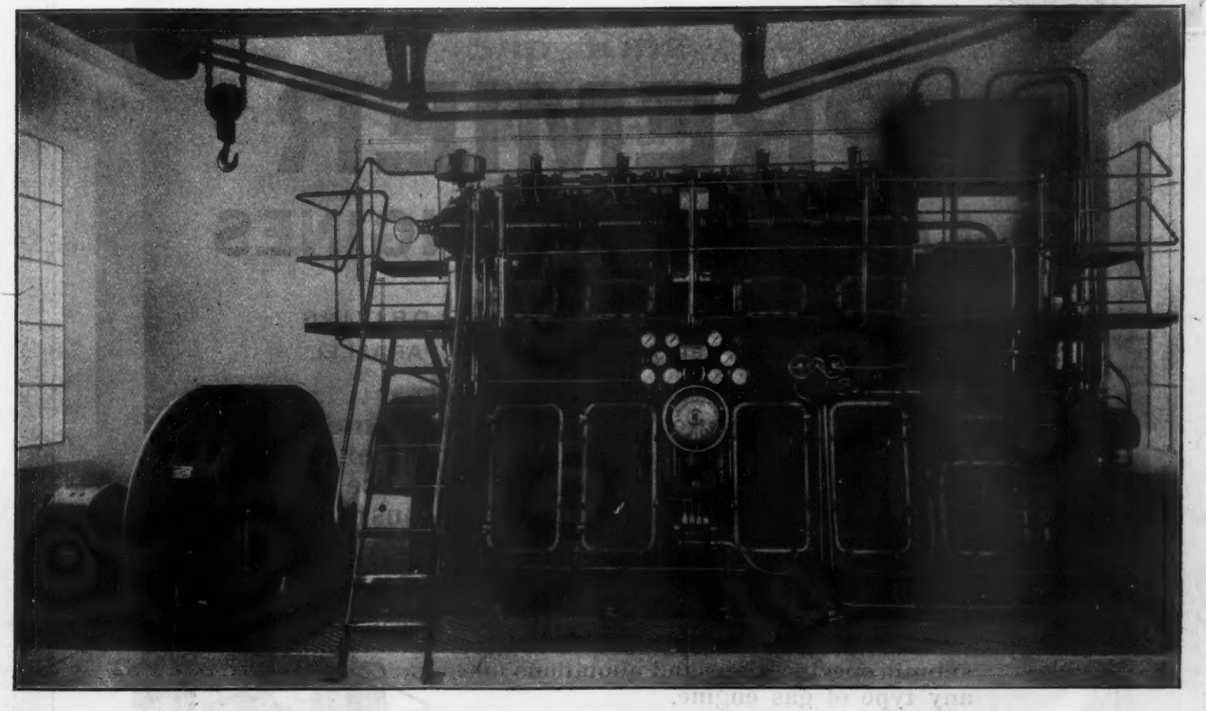
**Address:**
**TURIN (Italy),**
**20, Via Cuneo.**

**Telegrams:**
**Motorfiat-Turin.**

## TURIN, ITALY.

**BUILDERS OF**

## OIL, STATIONARY & MARINE ENGINES.



**Electric Power Unit, 575 HP.**

**Diesel Engines for any power requirement, Marine or Stationary, ranging in size from 80 to 6000 B.HP.**

---

**Semi-Diesel (hot bulb) Engines 12 to 70 B.HP.**

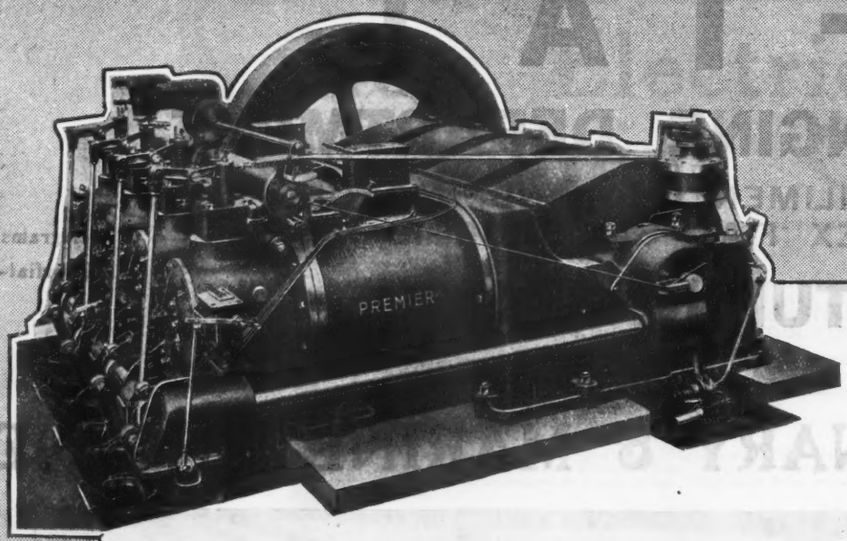
---

**Electric Power Units, Air Compressors, Pumping Units, etc., Oil Engine Driven.**

---

***CORRESPONDENCE INVITED.***

1776

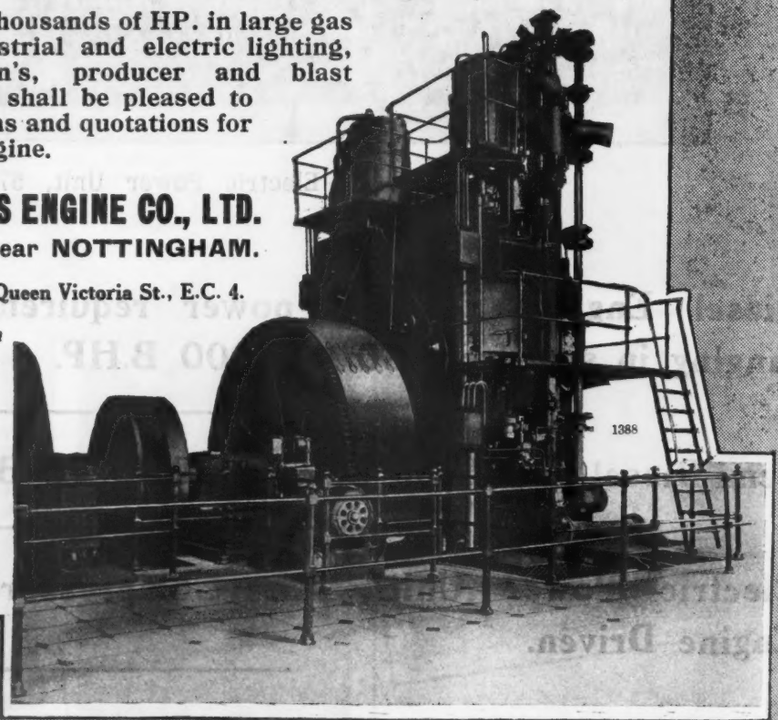



# PREMIER
## LARGE GAS ENGINES

SPECIALLY ADAPTED FOR DRIVING
DIRECT-COUPLED ALTERNATORS IN PARALLEL.

**We were the pioneers of large gas engines in this country, and our long and unique experience enables us to design and manufacture engines unequalled for economy and continuous reliability.**

**We have installed thousands of HP. in large gas engines, both industrial and electric lighting, working on town's, producer and blast furnace gases, and shall be pleased to submit specifications and quotations for any type of gas engine.**




**THE PREMIER GAS ENGINE CO., LTD.**
**SANDIACRE, Near NOTTINGHAM.**

**London Office :—139-141, Queen Victoria St., E.C. 4.**

***Branches and Agencies in all Principal Centres.***

P. 3

*The Standard for Simplicity and Correct Design.*

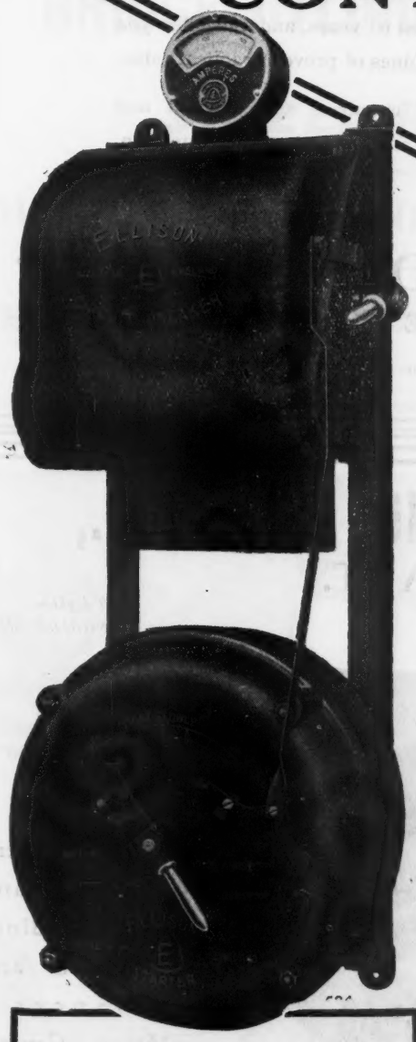
# ELLISON

**Air Break Air Cooled**

# STATOR and ROTOR CONTROL PANELS

*for*

**Slip Ring Induction Motors.**




Panel for Wall Mounting.

THE electric control gear literally controls the running of the plant.

It should not be loaded with "gadgets" but be made reliable, simple and accessible.

Be sure it is Ellison Make.

The same principle applies to group or individual motor drives, the right gear must be selected for the control if continuity of output is to be assured. The first cost of a fuse may be lower than an automatic circuit breaker, but if it "blows" on an overload or short circuit it costs *time* to re-wire, whereas a circuit breaker can be closed again at once by merely pushing a handle.

A separate breaker and starter interlocked, form the ideal apparatus for motor control. You were impressed with the new Ellison totally enclosed circuit breaker and motor starter as individual units, now we show that they can be mounted together on a frame or stand.

This gear will please the maintenance man, for the designer had him in mind all the time.

Send for List No. 71.

Panel for Floor Mounting.

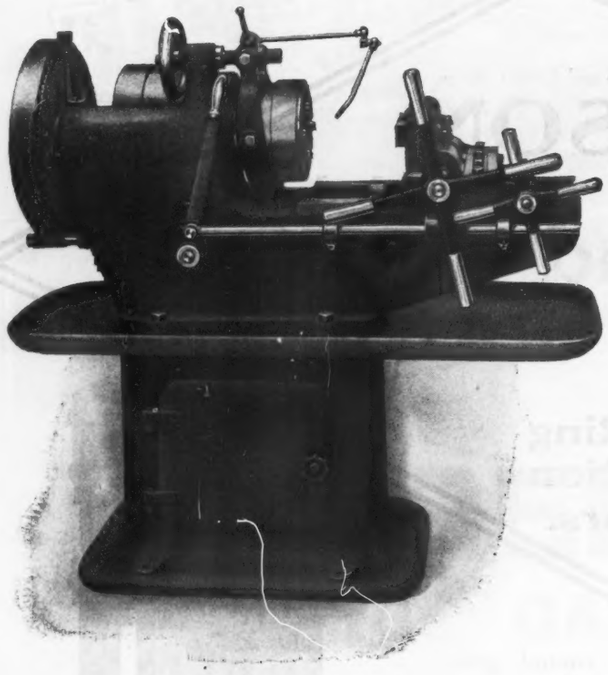
# GEORGE ELLISON

1549

**MAKERS OF ELECTRIC CONTROL GEAR.**

**WORKS: PERRY BARR, BIRMINGHAM.**

# SCREWING MACHINES.



1¼ IN. BOLT SCREWING AND NUT TAPPING MACHINE WITH AUTOMATIC DIE HEAD.

**Our Standard Lines are TUBE SCREWING MACHINES in various sizes up to 18 in. diameter, BOLT SCREWING MACHINES up to 4 in. diameter. We have specialised in these lines for almost 60 years, and can offer you machines of proved practical value.**

**Your enquiries are solicited and will receive our careful attention.**

## MAIDEN & CO., LTD.,

**HYDE, Near MANCHESTER.**

Telephone—29 HYDE. Tel. Add.—MAIDEN HYDE.

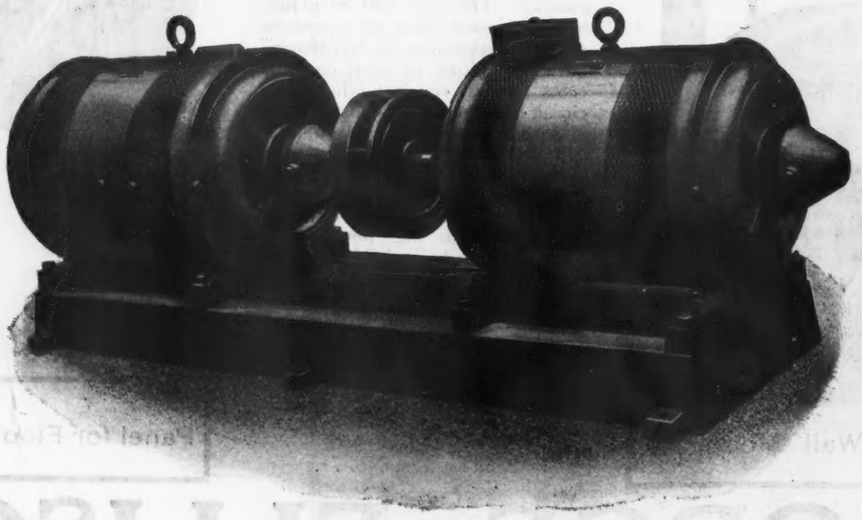
1259

# THE MACFARLANE ENGINEERING CO., LTD.,

## Netherlee Road, CATHCART.

*Telegrams:* *POWER, CATHCART.*

*Telephone:* *LANGSIDE 555.*



**A.C. & D.C. MOTORS**

for

Colliery, Engineering, and all general purposes, including :—Lift, Crane, Haulage, Pumping and Ventilation work.

**DYNAMOS**

for

Lighting, Battery Charging and Arc Welding Boosters and Balancers. Motor Generators for Cinema Work.

**Motor Generator Welding Set**—Output, 500 Amperes at 80 Volts, D.C.
Input, 440 Volts, 25 Cycles, A.C., 3-phase. Speed, 750 r.p.m.

**OUR OUTPUT IS OVER 1000 MACHINES PER ANNUM, AVERAGING ABOUT 30 HP.**

*Your Enquiries will have Prompt Attention.*

1071

# HEAD, WRIGHTSON & COMPANY, LTD.

***ENGINEERS AND IRONFOUNDERS.***

# OIL STORAGE TANKS.

## STRUCTURAL WORK of EVERY DESCRIPTION.

## BRIDGE CYLINDERS, TUNNEL SEGMENTS, &c.

## *STEEL, IRON & BRASS CASTINGS.*

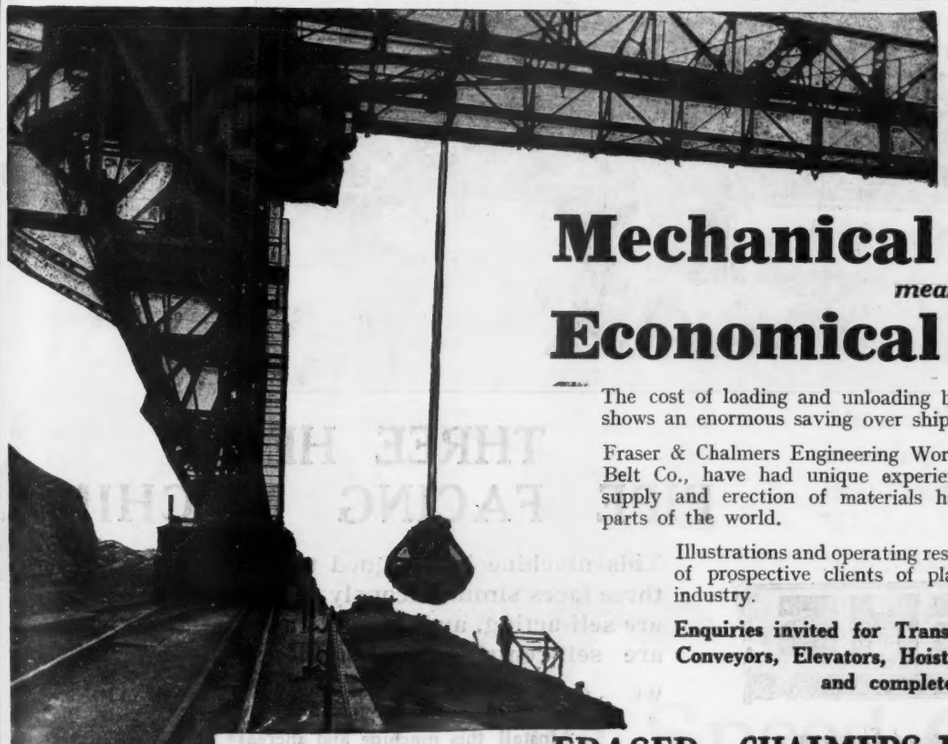
## OUTPUT OF FOUNDRIES - - 100,000 TONS PER YEAR.

**TEESDALE IRON WORKS,**
Thornaby-on-Tees.

Telegrams—
"TEESDALE,
STOCKTON-ON-TEES."

Also **STOCKTON FORGE WORKS & EGGLESCLIFFE FOUNDRY,**
Stockton-on-Tees.

7706



Fraser & Chalmers Grab Transporter unloading coal from barge to store heap at 200 tons per hour.

# Mechanical Handling
*means*
# Economical Handling

The cost of loading and unloading by the Fraser & Chalmers' method shows an enormous saving over shipping by other means.

Fraser & Chalmers Engineering Works combined with Robins Conveying Belt Co., have had unique experience and unqualified success in the supply and erection of materials handling and shipping plant in all parts of the world.

Illustrations and operating results are available for the inspection of prospective clients of plants installed in practically every industry.

**Enquiries invited for Transporters, Belt and Gravity Bucket Conveyors, Elevators, Hoists, Waggon Tipplers, Grabs, etc., and complete handling Plants.**

## FRASER & CHALMERS ENGINEERING WORKS

PROPRIETORS : THE GENERAL ELECTRIC CO. LTD.

ERITH, KENT

LONDON OFFICE:
Magnet House, Kingsway, W.C.2.

ASSOCIATED WITH ROBINS CONVEYING BELT CO. OF U.S.A.

1317

# For Gas, Water, Steam, STEEL PIPE LINES Oil, Air, Sewage, &c.

Light Lapwelded Steel Pipes,
Main Steam Pipes,
Loose Flange Joint Tubes,
Weldless Steel Tubes,
Boring & Casing Tubes,
Hydraulic Tubes,
Coils,
Fittings of all kinds.

Tubular Steel Tramway, Telegraph and Electric Light Poles,
Tubular Steel Davits,
Derricks, Masts, Posts,
Steel Plates,
Steel Castings,
Zinc Sheets,
Zinc Boiler Plates,
Ashford's Patent Tube-well Strainers.

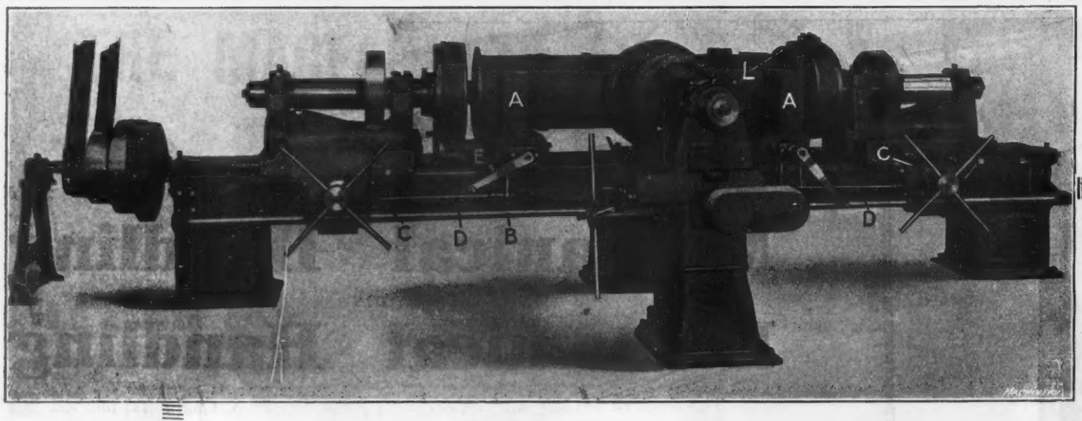
Steel Circulating Main 42 in. dia. installed at Shanghai.

*Catalogues sent on application.*

1537

## STEWARTS and LLOYDS, Ltd

GLASGOW: 41, Oswald Street. BIRMINGHAM: Broad Street Chambers. LONDON: Winchester House, Old Broad Street.




# THREE HEAD PIPE FACING MACHINE

**This machine is designed to face one, two or three faces simultaneously. The Patent Heads are self-acting, and do not chatter. The Vices are self-centring, adjustable, and powerful.**

WE CAN SUPPLY IN ANY COMBINATION.

**Install this machine and increase your production at least FOUR times.**

*Submit details of work to be done and we will quote you.*
*Send for Lists of Second-hand Machine Tool Bargains.*

1263

## HAIGHS
(OLDHAM) LIMITED.
GLOBE IRON WORKS, OLDHAM.

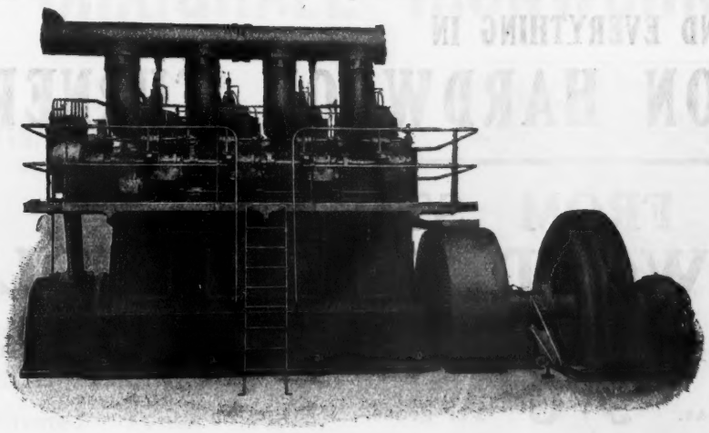
*London Office and Showrooms:*
**117-119, City Road, E.C. 1.**

*Telephones:*
1273 Oldham.
1950 Clerkenwell.

*Telegrams:*
Haigh, Oldham.
Iddusons, London.

# CAMPBELL

## COLD STARTING VERTICAL OIL ENGINES



320 B.HP. ENGINE with 3 PHASE ALTERNATOR. One of THREE SETS running in parallel.

**THE CAMPBELL**
**was the first**
**Vertical Oil Engine**

of the Solid Injection Cold Starting Type to be put on the Market.

**It Runs on the Lowest Grade Fuel Oils of 0·96 S.G.**

**CONSUMPTION 0·43 LB. PER B.HP. HOUR.**

*Standard Sizes:*
**70 TO 650 BRAKE HP.**

**THE CAMPBELL GAS ENGINE COMPANY, LTD., HALIFAX, ENGLAND.**

LONDON: 73A, QUEEN VICTORIA STREET, E.C. 4. GLASGOW: 104, BATH STREET. CALCUTTA: C3, CLIVE BUILDINGS.

9865

# VARIABLE SPEED GEAR

THESE hydraulic gears provide infinite changes of speed without steps from Zero to speed of Prime Mover, forward and reverse, with perfect and easy control and high starting torque.

Thousands are in use for many purposes including Ships' Steering Gears, Winches, Boat Hoists, Capstans, Windlasses, Colliery Winders, Haulage Gears, Coke Oven Rams, Wire Making Machinery, Textile Machinery, Petrol Rail Coaches, Riveters, Presses, Etc.

*Telephone:* VICTORIA 4361. *Telegrams:* VARISPEED, SOWEST, LONDON.

*The* Variable Speed Gear *Ltd.*,
*Broadway Court, Westminster, London, S.W.1.*

V·S·G

3691

# HANDLES.

*May we have your next enquiry for:—*

## PUMP HANDLES, TOOL HANDLES, WIRE BOBBINS
AND EVERYTHING IN
## SMALL REPETITION HARDWOOD TURNERY?

## WE CAN SUPPLY FROM STOCK HARDWOOD FILE HANDLES,

strongly ferruled, assorted sizes 3½ in. to 5½ in. by ½ in., ¾ in. and ⅞ in. dia. ferrules.

Per gross. **9/6** Per gross.

10 GROSS LOTS WE PAY CARRIAGE. Special quotation for larger quantities.

TERMS :—5% cash with order, 2½%—10th of month following date of invoice.

1670

*Made at:—*

## CAXTON WOOD TURNERY COY., MARKET HARBOROUGH.

# CHAIN GEARING.

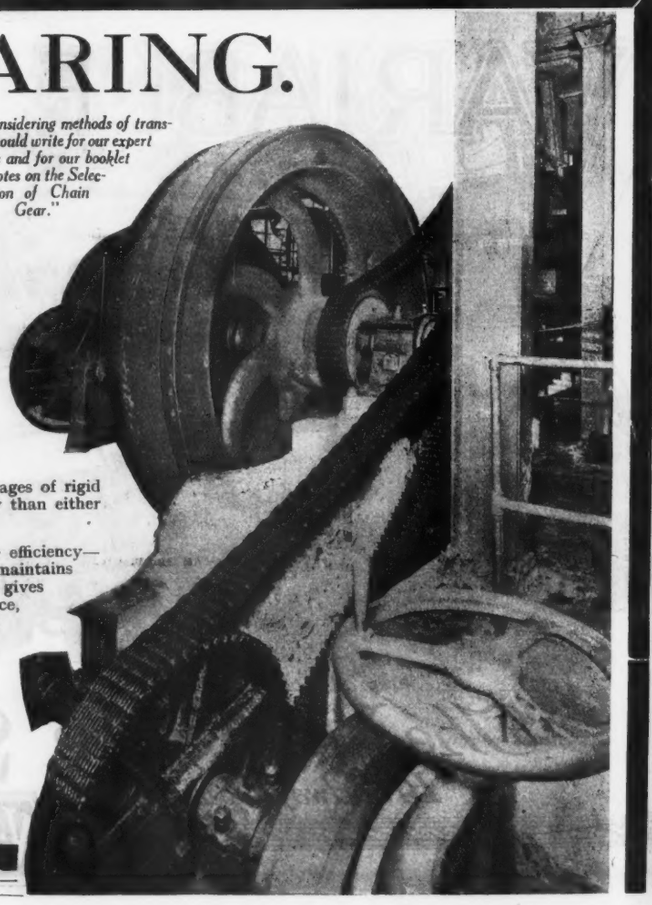
YOUR most honest worker is your Chain Drive. It is a worker that is reliable, economical, needs very little attention and is, above all, the most efficient in the world.

We feel it is essential that one should have honest and efficient workers to help, and that it is suicidal to "put up with" any but the best.

It is in the transmission system that power seeks its opportunity to run to waste—to expend itself without contributing any material gain to the work in hand.

Power losses mean money losses, but Chain Gearing is the preventative; it is an insurance against power losses.

*Engineers considering methods of transmission should write for our expert advice and for our booklet "Notes on the Selection of Chain Gear."*



Renold Chain Gearing combines the advantages of belts with the advantages of rigid gearing, but at the same time it is much more efficient and satisfactory than either type of drive.

A belt drive has an efficiency of 85%—90%; spur gearing has a higher efficiency—but this rapidly diminishes with the inevitable wear—whereas Chain Gearing maintains an efficiency of 98% throughout the whole of its working life. Chain Gearing gives a positive yet flexible drive; it is economical in first cost, cost of maintenance, power conservation and long life. Chain Gearing is simple of erection and in many cases is instrumental in very extensive space economies and convenient and compact drive arrangements.

# RENOLD

HANS RENOLD Ltd., DIDSBURY, MANCHESTER.

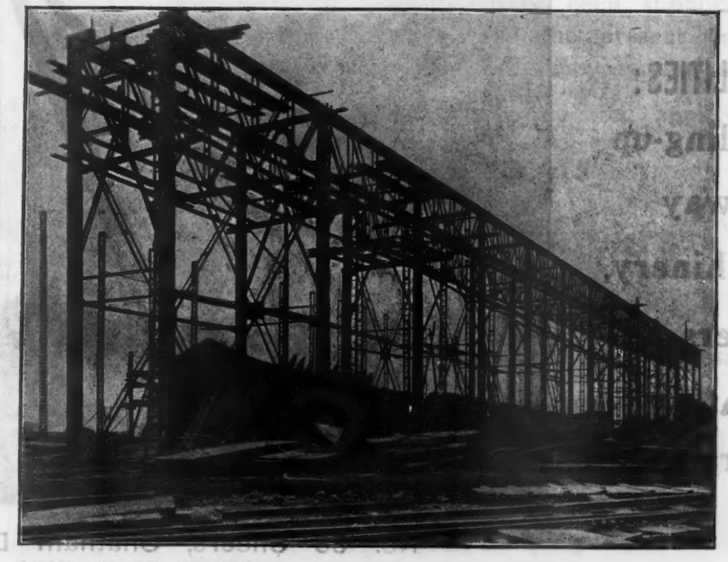
# THE STEEL CONSTRUCTION CO., LTD.

## CRAIGHALL IRONWORKS, GLASGOW.

London Offices—

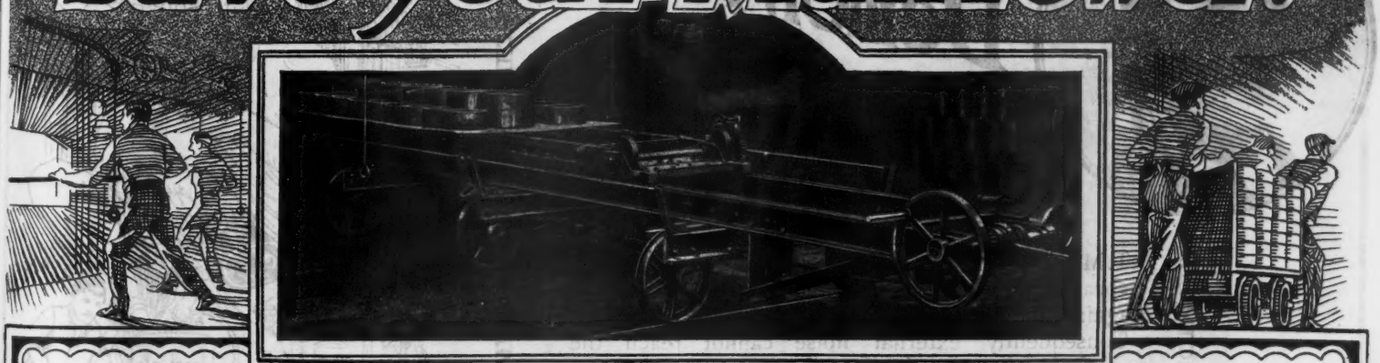
**118, CANNON STREET, E.C.4.**

**Designers, Makers and Erectors of Steel Framed Buildings, Riveted Tanks, Pipes, Hoppers and General Constructional Steelwork for Home and Export.**



8525

# Save your Man-Power!



ONE MAN CAN CHARGE OR DISCHARGE A 20 ft. 0 in. by 5 ft. 0 in. FURNACE With 2 tons of Sheets, Bars, Plates or Laps in 30 SECONDS WITH THIS MACHINE.

## PATENT (Furnace & Muffle) CHARGING MACHINES

GIBBONS BROS LTD. DUDLEY.

*Contractors to Admiralty & War Office Patentees & Builders*

*Telegrams:* "GIBBONS LOWER GORNAL." *Telephone:* 2450 DUDLEY (5 lines)

**ADVANTAGES.**

SAVING IN:—
LABOUR.
FUEL. 8525
TIME.
FURNACE REPAIRS.

INCREASED OUTPUT PER FURNACE.

BETTER QUALITY OF PRODUCT.

# DAY, SUMMERS & CO., LTD.,

## Northam Iron Works, SOUTHAMPTON.

ESTABLISHED 1834.

**Sole Manufacturers of the BRITISH KROMHOUT OIL ENGINES.**

*ENGINEERS and SHIPBUILDERS.*

**SPECIALITIES:**

**Hauling-up Slipway Machinery, Sheers, Floating Bridges.**

MANUFACTURERS OF BRITISH KROMHOUT MARINE OIL ENGINES
For full Particulars Prices &c. apply to PERMAN & CO. LTD. 82-83, Fenchurch Street, LONDON, E.C.4

Upwards of **90 Sets** of Land and Floating Sheers built at these Works.

No. 83 Sheers, Chatham Dockyard.
TESTED TO 180 TONS.

1191

# Demon Noise

Noise is your enemy. It prevents you using the natural method of communication, the voice.

Install T.M.C. Laryngaphones, and you have perfect telephone communication under the worst conditions.

T.M.C. Laryngaphones are operated direct by the vocal chords, because the microphone is held close against the larynx.

Consequently external noise cannot reach the microphone and only the voice is transmitted to the distant end. Equally you hear well, because no disturbing noise reaches your own receiver

*Laryngaphones are used for communication on aeroplanes.*

# TMC Laryngaphones

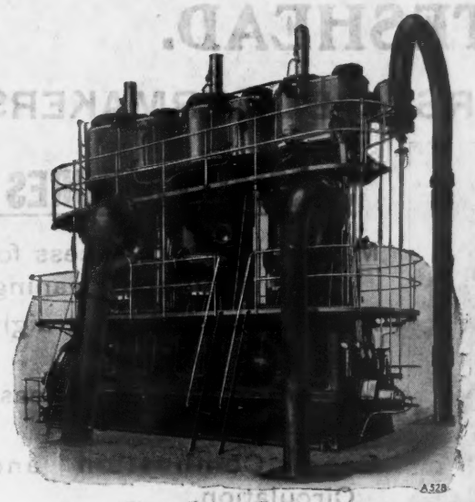
GUARANTEE PERFECT COMMUNICATION.

**The Telephone Manufacturing Co., Ltd.,**
**Hollingsworth Works, Dulwich, London, S.E. 21.**

*Telephone:* Sydenham 2460-1. *Telegrams:* "Bubastis, Dulcrox, London."

EPS. 107. At British Empire Exhibition, Wembley, 1924.

# "Sentinel" Air Compressors



Steam Driven Compressor.
Capacity 10,000 cu. ft. per minute.

**These** were the **original vertical enclosed self-lubricating machines** and were an immediate success, being accepted by the **British Admiralty** and at least 80 per cent. of the Shipbuilding Concerns in the country, solely on their own merits. Units up to 10,000 cub. ft. capacity have been supplied for general **Colliery Service,** and the present pattern still easily leads for durability, efficiency and reliability.

**No. 15. Air Catalogue** free on application.

**"Sentinel" Ash Hoists**

**"Sentinel" Steering Gears**

**"Sentinel" Valves**

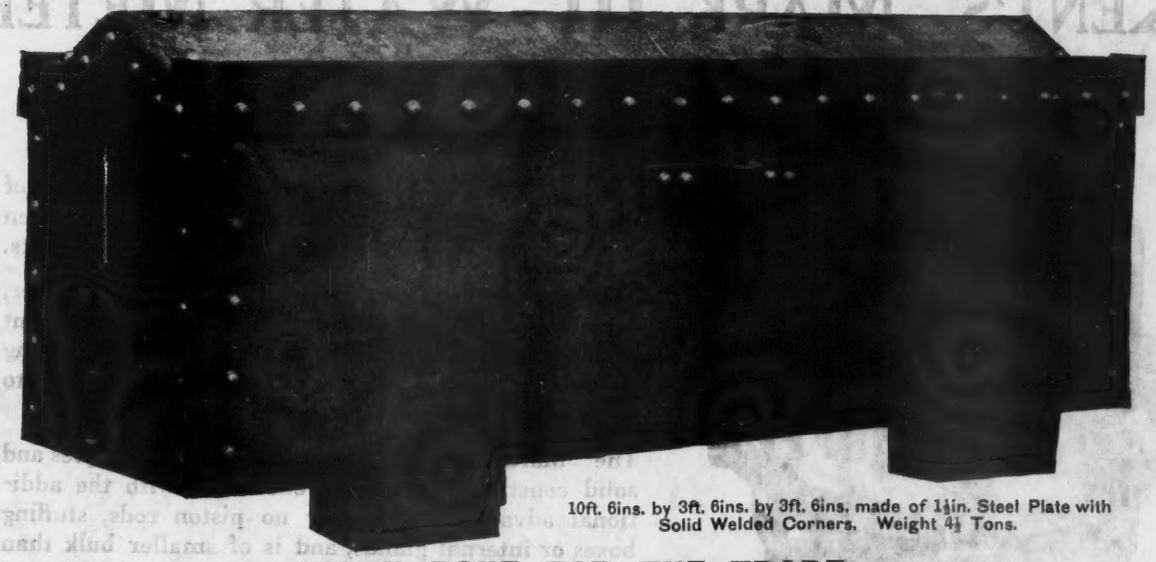
***(Made at Sentinel Valve Works, Worcester)***

## ALLEY & MACLELLAN, LTD.,

**Sentinel Works, - - GLASGOW.**

11

# ANNEALING COVER



10ft. 6ins. by 3ft. 6ins. by 3ft. 6ins. made of 1¼in. Steel Plate with Solid Welded Corners. Weight 4½ Tons.

***WORK DONE FOR THE TRADE.***

## RIVETED AND WELDED TANK WORK

OF ALL DESCRIPTIONS.

1282

*Estimates free from—Manager, TANK DEPARTMENT,*

## THE STEEL BARREL CO., LTD.,

Telephone: UXBRIDGE 251.

**UXBRIDGE, MIDDLESEX.**

Telegrams: "BARRELS, UXBRIDGE."

# CLARKE, CHAPMAN & CO., LTD.,

VICTORIA WORKS, GATESHEAD.

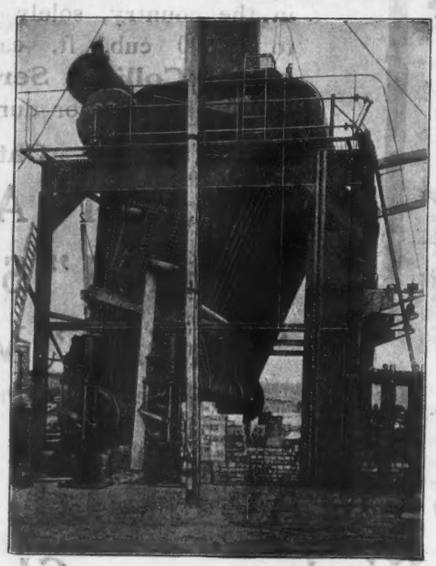
GENERAL & ELECTRICAL ENGINEERS & BOILERMAKERS.

## WATERTUBE BOILERS.

"WOODESON'S"

PATENTS

FOR ALL DUTIES.



Installation of Two Woodeson Boilers, with Superheaters, supplied to large Power Station in Lancashire.

**SPECIAL FEATURES:**

Maximum ease of access for examination and cleaning.

All heating tubes straight and of equal length.

Maximum steam release areas.

Good Combustion and Circulation.

Ease in erection.

Large steam space.

665

LONDON OFFICE:
116, Fenchurch Street, E.C. 3.

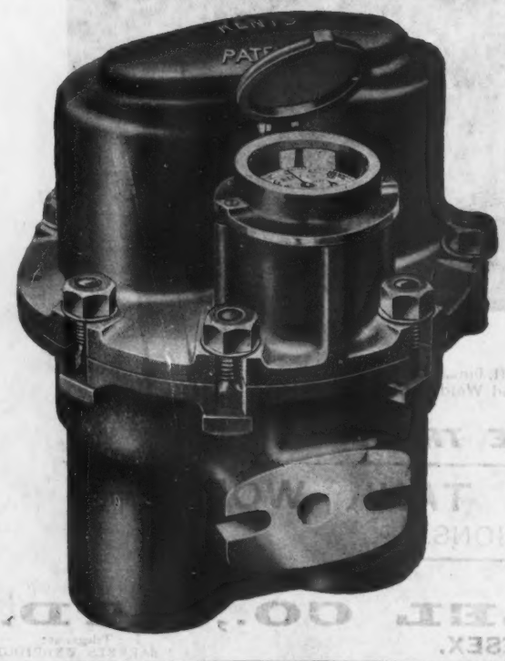
Telegrams—"Cyclops, Fen, London."

Telegrams: CYCLOPS, GATESHEAD.
Telephone Nos.: GATESHEAD 773 (4 lines).

CODES:—
A. B. C. 4th, 5th & 6th Editions, A 1, Engineering, 1st & 2nd Editions, Lieber's, Broomhall's, Moreing & Neil's, Watkins, Western Union, Marconi International, Bentley's Complete Phrase Code, and Private.

# KENT'S "MARK III" WATER METER

## Positive Packed Piston Type.



The Kent "Mark III" Positive Meter is an evolution of the well-known Kent "Standard" type which has been on the market many years and given excellent results.

The design known as the "Mark III" Meter is, however, a considerable advance upon the former type on account of the important reduction in the number of working parts, tending to increase the life of the meter, and to effect a considerable reduction in maintenance costs.

The "Mark III" Meter retains the sound principles and solid construction of its predecessor, with the additional advantage of having no piston rods, stuffing boxes or internal glands, and is of smaller bulk than any other positive meter giving the same deliveries.

George Kent Ltd
LONDON & LUTON

1117

Sales Office:—199, HIGH HOLBORN, LONDON, W.C.1.

Glenfield & Kennedy, Ltd
KILMARNOCK

# "ISMAILIA" VALVES,

## FOR PUMPS AND REFLUX VALVES.

ADVANTAGES:

Ismailia valves are instantaneously removed and replaced by hand, without the use of tools.

Ismailia valves are rigid when open, free when closed and locked in position when working.

Ismailia valves have nothing to work loose, therefore, they cannot come adrift from their seats.

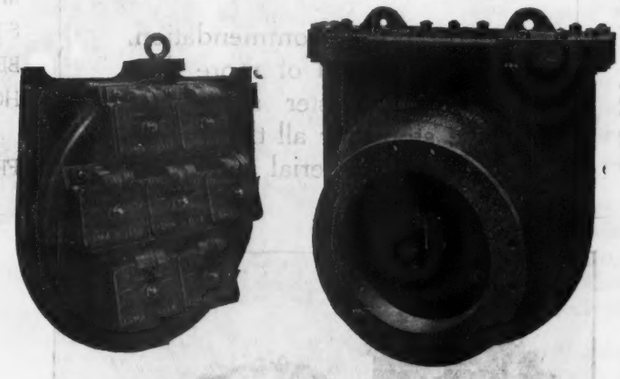
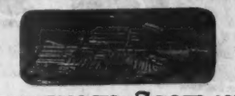


ILLUSTRATION shows one of four 20 inch reflux valves, our M4 pattern, fitted with seven rectangular flap valves of the Bowden-Smith (patent No. 648/1914) Ismailia type, recently supplied by us for Portsmouth Main Drainage.

All Waterworks Accessories.
Dock Machinery.
Hydraulic Machinery.
Hydraulic Valves.
Irrigation Machinery.
Johnson-Boving Control Valves.

**GLENFIELD AND KENNEDY, LTD.**



KILMARNOCK, SCOTLAND.
London Office: 39, Victoria St., Westminster, S.W.I.

Kennedy Patent Meters for Water and Oil.
Peebles Patent Sandwasher.
Pumping Machinery.
Sluice Valves for Water and Oil.
Storage Dam Draw Off Valves.
Throttle Valves

1634

TRADE SIROCCO MARK

# STEAM REMOVAL PLANT.

Maintains a clear atmosphere in Laundries, Dye Houses, Paper Mills, etc. Thoroughly effective, even in the most troublesome cases; its first cost is low, it is economical in operation, condensation is prevented, and the temperature of the atmosphere not materially increased.

*Full particulars gladly given on request.*

# FUME REMOVAL PLANT.

Deals effectively with Fumes of every kind. By removing corrosive fumes on the induction principle, the fan is protected from the action of the gases, thus avoiding the expense of frequent renewals.

# DAVIDSON & CO., LTD.,

SIROCCO ENGINEERING WORKS,
BELFAST.

3569

# ASTER

PARAFFIN, PETROL & GAS

# ENGINES

need no recommendation. Over a period of more than 20 years Aster specialities have stood for all that is best in design, material and workmanship.

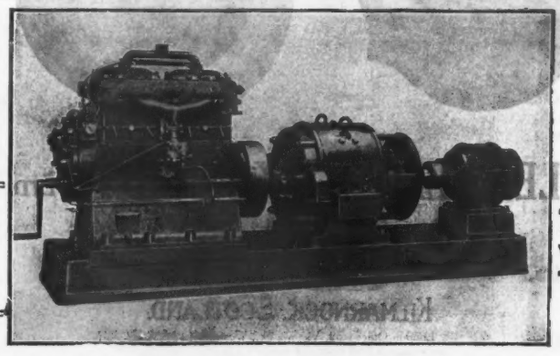
STILL AT WORK AFTER 21 YEARS

*"In August of 1902 you erected for me one of your B5 Electric Combined Engine and Dynamo Sets with the necessary wiring, etc. I shall be obliged if you will send me a new set of piston rings, also an exhaust and inlet valve."*

The above letter, just received, demonstrates the exceptional length of Service obtainable from an Aster Engine. It proves indisputably the quality of materials and grade of workmanship incorporated in Aster specialities.

*ASTER SPECIALITIES:*

COMPRESSOR SETS.
ARC WELDING SETS.
MARINE & PUMPING SETS.
STATIONARY ENGINES.
BELT DRIVING SETS.
HOUSE LIGHTING SETS,
ETC., ETC., ETC.
FROM 5 HP. to 450 HP.



FREE PRACTICAL DEMONSTRATIONS ARRANGED ON REQUEST.

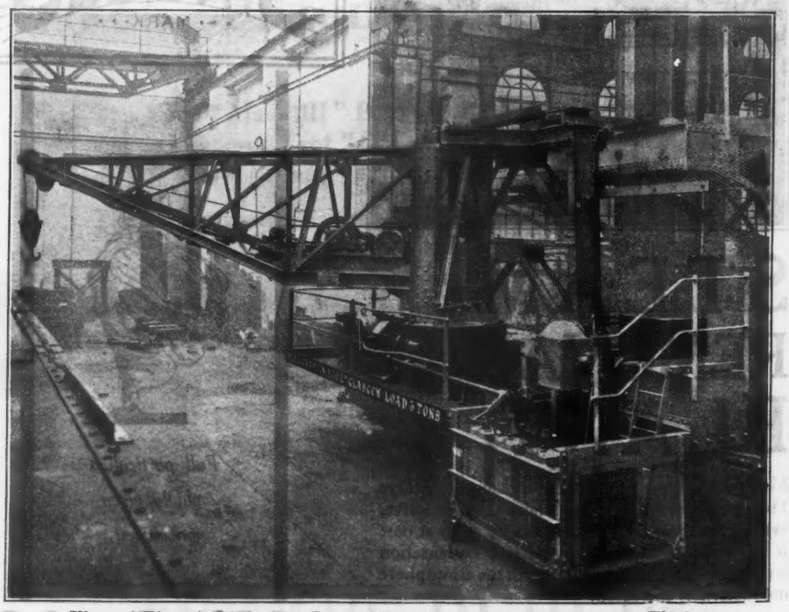
**The ASTER ENGINEERING Co. (1913) Ltd.**
WEMBLEY - - MIDDLESEX.
Telephone - Wembley 22 and 23.

1088

# "Chaplin" Cranes

FOR

ENGINEERING SHOPS,
SHIPYARDS,
RAILWAYS,
and
Ddocks.



View of Electric Mono-rail Crane in course of construction in our Works

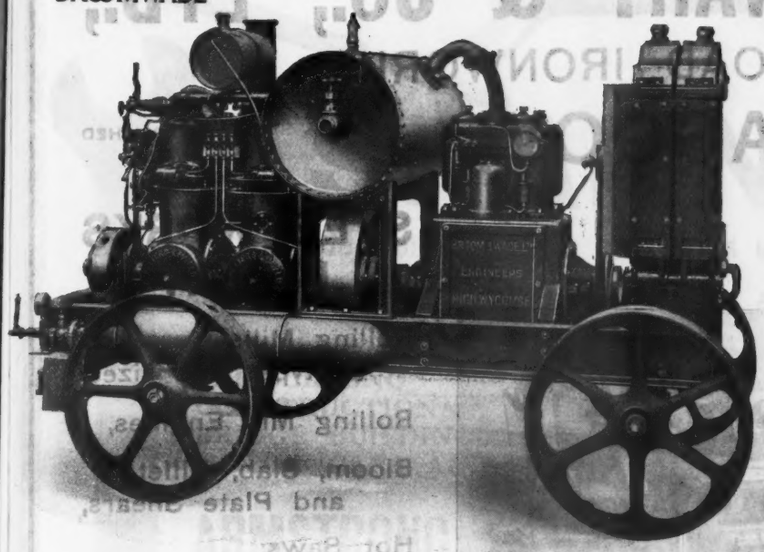
Liverpool Office:
The Wm. Roman Co., Ltd.,
329, Tower Buildings,
Water Street, Liverpool.

**ALEX. CHAPLIN & CO., LTD.,** Govan, GLASGOW.

1183

BROOMWADE

# Cheaper Compressed Air



THE "Broomwade" Crude Oil Driven Portable Compressor fitted with patent cold starting device, by means of which it is possible to start the engine at any time in a few seconds, with a minimum of trouble and without the use of blow lamp or electrical apparatus.

Guaranteed to actually deliver 120 cubic feet of free air per minute at 100 lbs. pressure, with a fuel cost of less than 6/- per day of 8 hours—a saving of more than 80% compared with a petrol driven set of similar capacity.

Of simple and robust design, this plant compares favourably with a well-designed steam set for economy in operation and reliability. Built in Four sizes, delivering 58, 86, 120, and 180 cubic feet respectively.

*We make compressors in all sizes up to 1,200 cubic feet per minute, arranged for any drive to suit customers' requirements.*

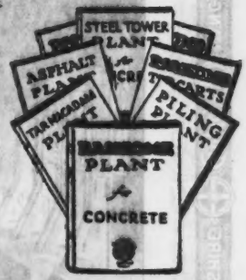
BROOM & WADE LTD
HIGH WYCOMBE

1286

# RANSOME
ALL BRITISH

THE MARK OF THE MAKE THAT *LASTS* AND
"The wise buyer's choice."

## CONCRETE, PILING AND TAR MACADAM




PLANT, Mixers, Steel-Tower Concrete Placing Plants, Asphalt Plants, Moulding Press for Concrete Products, Hoisting Winches, Bar Cutters, Steel Piling, Steel Hand Tip-Carts, etc.

Send details of your needs to DEPT. E, and we will forward appropriate catalogue and quotation. Ask about the popular Ransome Runabout Concrete Mixer, output 7·5 cubic yards per hour.

Write for Catalogues to DEPT. E.

843

RANSOME MACHINERY CO. (1920) LTD., Dept. E, 14-16, Grosvenor Gardens, LONDON.

# PLANT

*FOR CONTRACTORS, CONSTRUCTIONAL ENGINEERS, SURVEYORS, QUARRY OWNERS, &c.*

# DUNCAN STEWART & CO., LTD.,

LONDON ROAD IRONWORKS,

GLASGOW.

Tel. Address—
"STEWART, GLASGOW."

ESTABLISHED
1864.

## HYDRAULIC MACHINERY.

Steam Hydraulic Forging Presses,

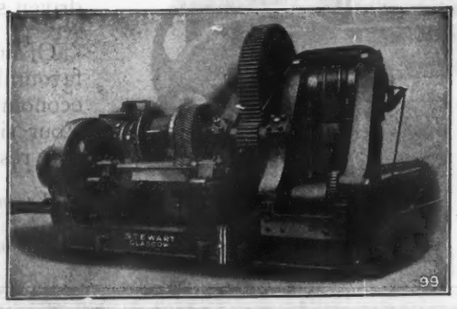
Shaft Straightening Presses,

Troughing Presses,

Accumulators,

High Pressure Hydraulic Pumps,

Etc.



Electrically-Driven 12 in. by 6 in. Billet Shears.

## STEEL WORKS PLANT.

Rolling Mills, all types and sizes,

Rolling Mill Engines,

Bloom, Slab, Billet and Plate Shears,

Hot Saws,

Steam Hammers,

Tube Drawbenches,

Etc.

6826

LANCASHIRE Crypto LANCASHIRE Crypto LANCASHIRE Crypto LANCASHIRE Crypto

# For Mining Electrical Drives

LANCASHIRE SQUIRREL CAGE MOTORS DRIVING COLLIERY SCREENING PLANT.

*Send for particulars and become familiar with the superiority of LANCASHIRE & CRYPTO design and construction.*

The LANCASHIRE DYNAMO & MOTOR CO. LTD.
associated with The CRYPTO ELECTRICAL CO. — LTD.

Trafford Park, Manchester. Willesden, London, N.W.10.
LONDON OFFICE AND EXPORT DEPT.: 28, VICTORIA ST., S.W.1.

## LANCASHIRE

HIGH TORQUE, EASY TO START,

# SQUIRREL CAGE MOTORS

**are the simplest, most reliable and economical electric motors yet devised.**

*No insulated rotating parts, no slip rings or brush-gear, no oil lubrication, no air-gap adjustments and no complicated switchgear.*

**No need to install Slip Ring motors except for Haulages.**

*See Exhibits at our Stand in the Electrical and Allied Engineering Section*
**BRITISH EMPIRE EXHIBITION, 1924.**

1366

D.R.K. 92.

Crypto LANCASHIRE Crypto LANCASHIRE Crypto LANCASHIRE Crypto LANCASHIRE

# SPANNERS.

**Single and Double-Ended. All sizes up to 2" supplied from stock.**

***SPECIAL SPANNERS* made for following trades:—**

ENGINEERING
SHIPBUILDING
CONSTRUCTIONAL
BRIDGE BUILDINGS
MOTOR CARS AND LORRIES
AGRICULTURAL IMPLEMENTS
RAILWAY PERMANENT WAYS
MACHINE TOOLS
LOCOMOTIVES
WATER DEPARTMENTS

**ARMSTRONG, STEVENS & SON, LTD.,** WHITTALL ST., BIRMINGHAM.

WORKS:—WILLENHALL.

***PRICES QUOTED ON APPLICATION.***

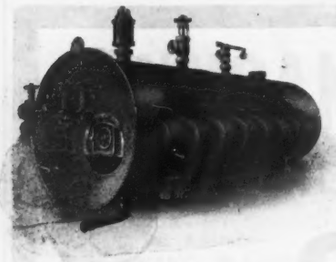
8075

CYCLONE
HIGH SPEED STEEL
H.R.D.

TYRES
AXLES SPRINGS
and BUFFERS
STEEL CASTINGS and FORGINGS
BILLETS · BLOOMS · BARS
TOOL STEEL for ALL PURPOSES
MANGANESE STEEL
CRUSHER ROLL SHELLS
SHOES and DIES
PIT RAILS
FILES

CAMMELL LAIRD & Co., LTD.
SHEFFIELD
LONDON OFFICE
3, Central Buildings, Westminster, S.W.

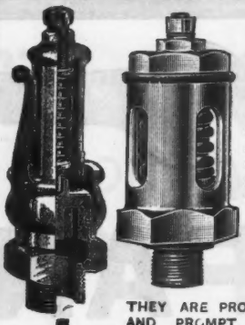
1341



# TANKS & BOILERS

1733

WM. ARNOLD & CO. VICTORIA IRON WORKS, BARNSLEY.



## RELIEF VALVES

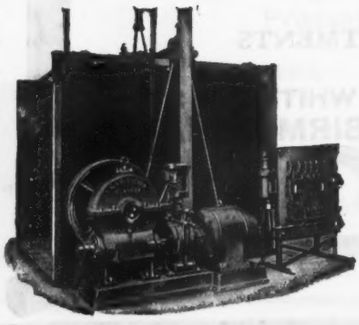
THESE VALVES are designed on the most modern principles and are reliable, accurate, sensitive and easily adjusted, open and close promptly with a minimum of margin and will not stick.

The Springs are coppered to avoid corrosion. They are suitable for use with Pumps, Feed Water Heaters, Hydraulic Lifts, Hot Water Boilers, &c.

THEY ARE PRODUCED IN LARGE QUANTITIES AND PROMPT DELIVERIES CAN BE GIVEN.

BRITISH STEAM SPECIALTIES LTD.
BEDFORD STREET, LEICESTER.

## LIFTS. A. & P. STEVEN, LTD.



181, St. James' Rd.,
GLASGOW.

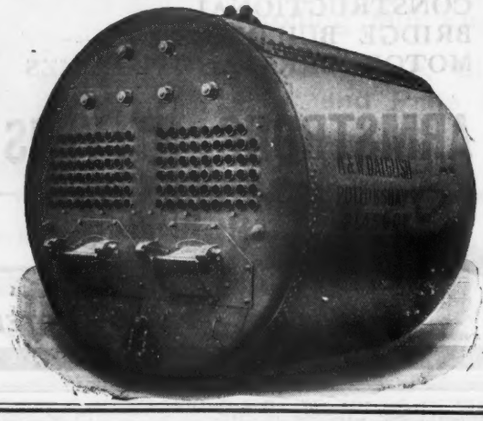
London Office:
10, CHARLES STREET,
BLACKFRIARS, S.E. 1

Manchester Office:
12, CHARLES STREET.

Birmingham:
HARRY ASTBURY,
DAIMLER HOUSE,
PARADISE STREET. 716

TELEGRAMS—*Evaporate, Polishaven.*
CODES—A B C, 5th Edition.

## A. & W. DALGLISH,



WEST OF SCOTLAND BOILER WORKS,
*Pollokshaws,*
GLASGOW.

MARINE, DRYBACK, LOCOMOTIVE and MULTITUBULAR BOILERS.

*ALL SIZES.*

1989

MADE BY THE MOST IMPROVED MACHINERY.

## ELECTRIC DRILLING MACHINES.

TOOL and TOOL MACHINERY of all DESCRIPTIONS DRIVEN BY ELECTRICITY.

The product of 28 years' experience.

UNIVERSAL PORTABLE.

Unsurpassed in Light Weight and Durability. Suitable for all classes of engineering. Thousands of these machines have been sold and have given every satisfaction, and are bringing in repeat orders. Low Price.

C. JACKSON & CO. (Manchester), LTD.,
18, Long Millgate, Manchester. 1671

OUR SPECIALITY.

## VALVES

FOR ALL STEAM PURPOSES

## A. COCKBURN & Co.

THISTLE VALVE WORKS, GATESIDE STREET,
GLASGOW.

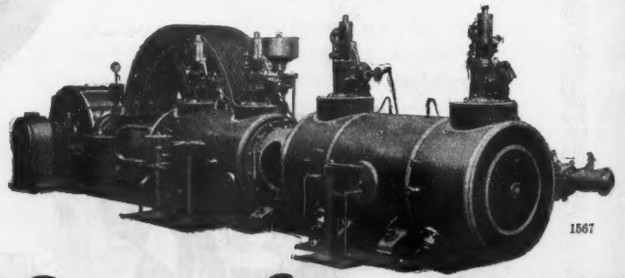
1716

## EDWARD LE BAS & CO.,

COILS for Chemical Plants, Etc.

COILS for All Purposes.

DOCK HOUSE, BILLITER ST., LONDON, E.C. 3.
And CYCLOPS WORKS, MILLWALL, E. 14.



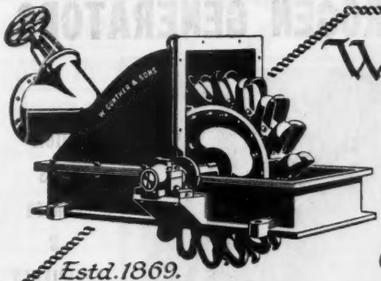
1567

## GALLOWAYS

LIMITED
MANCHESTER
ENGINE BUILDERS and BOILER MAKERS
Telephone 6312 Central.

TANDEM HEAT EXTRACTION ENGINES. This type of engine is specially suitable for Bleach Works, Dye Works, Paper Mills, Breweries, Flour Mills, Biscuit Manufacturing and all works in which considerable quantities of low-pressure manufacturing steam are required in addition to high-pressure steam for power purposes.

London Office: 120, Mansion House Chambers, 11, Queen Victoria Street, E.C. 4.



# WATER POWER.

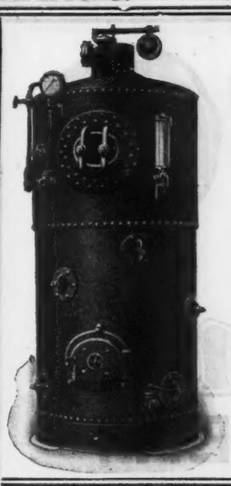
Francis Turbines and Pelton Wheels for all heads or powers. Oil Pressure Governors.

*Estd. 1869.*

## W. GUNTHER & SONS,

CENTRAL ENGINEERING WORKS, OLDHAM.

1344



*High Class*

VERTICAL STEAM BOILERS.
CORNISH STEAM BOILERS.
STORAGE CYLINDERS (Welded or Riveted).
AIR RECEIVERS. CALORIFIERS and FEED WATER HEATERS.
JACKETED PANS in Iron or Copper.
CORNISH TUBULAR BOILERS.
VERTICAL TUBULAR BOILERS.
UNDERFIRED TUBULAR BOILERS.

*Boilers of all kinds for :—*
CENTRAL HEATING & HOT WATER SUPPLY in Iron, Steel and Copper.

1689

## LUMBYS LIMITED,

**Greetland Boiler Works, HALIFAX.**

Telegrams: Lumbys, Greetland. Telephone: 125 Elland (2 lines).

THE NAME BEHIND THE PIN

FOR **TAPER PINS,** ACCURATELY MACHINED

WRITE

**FRED^K. MOUNTFORD (BIRMINGHAM) LTD.,**

FREMO WORKS, MOSELEY STREET, BIRMINGHAM.

1290

Delivery ex Stock. Any Size. Any Taper

ON ADMIRALTY AND WAR OFFICE LISTS.

## PEGLER BROS. & CO. (Glasgow), LTD.

Registered Office :— 54-60, BROWN STREET,

Works :—Bridgeton Smelting Works, Fordneuk Street, **GLASGOW.**

**BRASS & IRONFOUNDERS.**

MAKERS OF ALL KINDS OF HIGH CLASS
**ENGINE & BOILER FITTINGS.**

MAKERS OF
**SANITARY & WATER FITTINGS.**

*Catalogue on application.*

1628

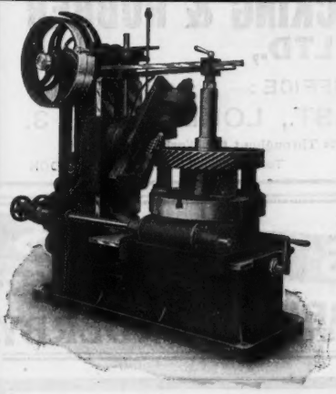
Tele.: "GUNMETAL." 'Phone: 3240 CENTRAL.

1196

FOR PERFECT
**FACTORY HEATING**
USE
**"THERMOVENT" UNITS**
ADAPTED FOR
**HIGH OR LOW PRESSURE STEAM.**
*TO WRITE FOR FULL PARTICULARS*

**DALLOW, LAMBERT & CO. LTD.,**

63, QUEEN VICTORIA ST., LONDON. SPALDING ST., LEICESTER.



## H. T. H.
**Automatic High Speed Gear Cutting Machines**

***Spur and Spiral Wheels.***

| Diameter inches. | Pitch diametral. | Price £ |
|---|---|---|
| 16 | 4 | 245 |
| 22 | 4 | 270 |
| 32 | 2 | 370 |
| 42 | 2 | 415 |

1561

**Humpage Thompson & Hardy,** High Class Machine Tool Makers, BRISTOL.

*Speciality*
**FACED & BRIGHT NUTS**
*LISTS ON APPLICATION*

**JAMES WILEY & SONS LTD DARLASTON.**

BRIGHT DRAWN STEEL BARS. 1280

# HARTNESS
**Automatic Opening**
# DIE HEADS

**assure accurate pitch and lead—long threads or short; are completely interchangeable, positive opening, durably constructed and extremely economical.**

*Catalogue giving full particulars gladly sent on request.* 1486

## Jones & Lamson Machine Co.,

9 & 10, Water Lane, Queen Victoria Street, LONDON, E.C. 4

EXPANSION GLANDS
NEVER JAMB WHEN
PACKED WITH

TRADE MARK.

Beldam's
"A" SERPENT

PACKING.

*Being made of Asbestos and White Metal diagonal layers is most sensitive and accommodates itself to any movement of the Steam Pipe Glands. Withstands the highest pressures and temperatures.*

*Sole Patentees and Manufacturers:* EST. 1876.

THE BELDAM PACKING & RUBBER CO., LTD.,
HEAD OFFICE:—
29, GRACECHURCH ST., LONDON, E.C. 3.
And at All Principal Ports Throughout the World.
Telephone: AVENUE 5204. 1746 Telegrams: "VEEPILOT," LONDON.

LOWEST PRICES FOR
HIGH CLASS CASTINGS
FOR ENGINES, MOTORS, MACHINE TOOLS, &c. FROM ENGINEERS' DRAWINGS OR PATTERNS.
ROE & HARRISON LTD.
Globe Foundry, STORES ROAD, DERBY.
ON ADMIRALTY AND WAR OFFICE LISTS.

GUEST & CHRIMES LTD.,
ROTHERHAM.
(On Admiralty, War Office & Crown Agents' Lists.) Established 1840.

WATER FITTINGS OF ALL DESCRIPTIONS.

UNEQUALLED FOR MATERIAL, WORKMANSHIP & FINISH.

1348
GUEST & CHRIMES LTD., ROTHERHAM.

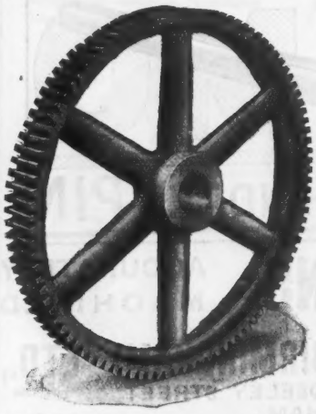
OXYGEN HYDROGEN GENERATORS.

LOW FIRST COST & UPKEEP.

HIGH GAS PURITY & EFFICIENCY.

BATTERY IN A LONDON WORKS. 1769

THE INTERNATIONAL ELECTROLYTIC PLANT Co., Ltd.,
NEW CRANE STREET, CHESTER.



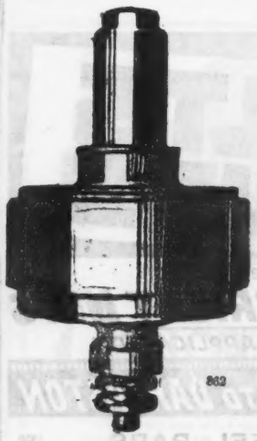
MACHINE CUT WHEELS.

WORM AND SPUR REDUCING GEARS.

The REID GEAR CO.,
LINWOOD, 1693
*near PAISLEY.*

CRANES
ALL TYPES.
ELECTRIC, STEAM, HYDRAULIC, HAND,
FOR
SHIPYARDS, DOCKS, STEEL WORKS, ETC.

JOHN GRIEVE & Co.
MOTHERWELL, SCOTLAND. 1099



THE "BEE" GOVERNOR
(EASTWOOD'S PATENT).
FOR MAXIMUM PRODUCTION
Governor makes the same R.P.M. at every position of Governor sleeve.

The Engine is under AUTOMATIC CONTROL at full speed, at all loads from the moment the sleeve moves on starting up.

The value of Output of Factory is increased BY 2 TO 10% due to constant maximum speed maintained with full or reduced Boiler pressure and partially loaded Engine.

Less wastage of material; all parts enclosed; fewer breakages; fewer stoppages of machines; better quality of products. SENSITIVE. DURABLE.

862
*SOLE MAKERS* THE UNIVERSAL VALVE & CHEMICAL ACCESSORIES Co.,
DUDLEY HILL, BRADFORD.
Telegrams: "Became" Dudley Hill. 'Phone: 56 Dudley Hill.

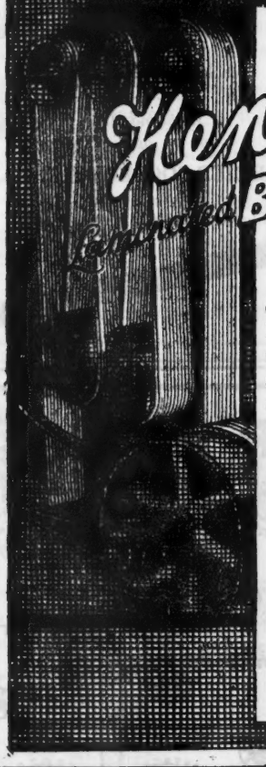
The Original & Genuine
**HAMMERED CAST IRON PISTON RINGS**
(By the Davy-Robertson Process.)
In our special quality 2K8 piston ring iron, giving 14 to 16 tons tensile per sq. in.
All sizes up to 72" dia.

Our Hammered Piston Rings are well and favourably known all over the world for their efficiency and long wearing qualities. They keep the cylinders round and maintain a perfect joint until worn out. The pressure on the cylinder wall always remains constant.

The Standard Piston Ring & Engineering Co., Ltd.,
Premier Works, Don Road,
SHEFFIELD.

Quick Delivery. Absolutely Reliable. Low Prices. 'Phone—No. 2149. 'Grams—"Ocean, Sheffield."

The Belt Built for Better Driving



Hendrys' Laminated BELTING

THE ingenious construction of HENDRYS' BELTING gives an unequalled flexibility and entirely obviates slipping or vibration. A HENDRY BELT will give a satisfactory drive over the smallest of pulleys when all other belts have failed.

*Write for Booklet.*

Sole Patentees and Makers:
JAMES HENDRY, LTD.
*Laminated Leather Works,*
Bridgeton,
GLASGOW.

**SUBMERSIBLE MOTORS LTD.**
'Phone—SOUTHALL 2. SOUTHALL, Middx. Telegrams—SUBMERSE, SOUTHALL.
A.C. & D.C. MOTORS DYNAMOS
ALTERNATORS & MOTOR GENERATORS
*PRICES GREATLY REDUCED.*

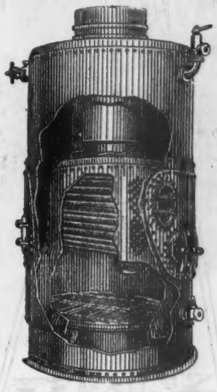
Enclosed Ventilated Ball Bearing Dynamo.

SPECIALITY—
SUBMERSIBLE ELECTRIC MOTORS FOR PUMPING AND WET POSITIONS.
1837

*THEY WORK IN WATER.*

**SPENCER-HOPWOOD**
*(Reg stered Trade Mark).*

STEAM BOILERS



Are Used All Over The World.

Up to 5,000 lbs. Per Hour Evaporation.

British Patents 185,635; 190,853; etc.

Ten Advantages
Over All Other Vertical Boilers.

1. Full Steam Pressure from Cold Water in 30 Minutes.
2. Higher Efficiency.
3. More Portable.
4. 33% Overload Capacity.
5. More Accessible for Cleaning.
6. Longer Life.
7. Lower Maintenance Costs.
8. Flue only 5-feet High.
9. Higher Evaporation for Size.
10. Greater Heating Surface for Size.

**SPENCER-BONECOURT, Ltd.**
Engineers and Boilermakers,
Parliament Mansions, Victoria St., London, S.W.1
WORKS: HITCHIN, HERTS.
'Phone: Victoria 5563. Telegrams: Bonecourt, Phone, London.
1298

**HIGGINBOTTOM & MANNOCK, LD.**
Crown Iron Works, West Gorton, MANCHESTER.
Telegrams:—CROWN, GORTONBROOK.

O 8368

Electric Cranes, Hoists, Capstans, Winches, Traversers, Transporters, Hauling Machinery and Hand Cranes, Hand and Power Runways, Pulley Blocks.

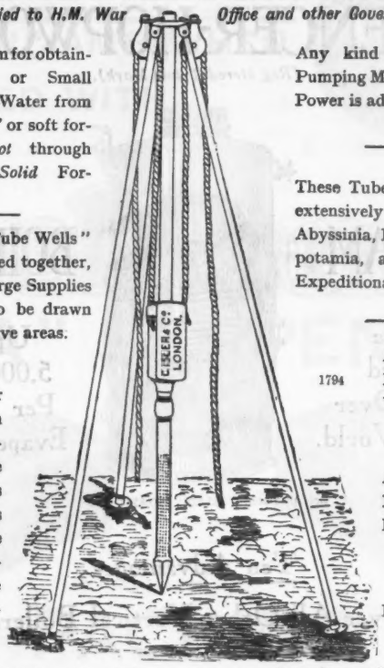
## C. ISLER'S
## IMPROVED TUBE WELL & DRIVING APPARATUS

*As supplied to H.M. War Office and other Governments.*

Rapid System for obtaining Large or Small Supplies of Water from "Alluvium" or soft formations, *not* through *Rocks* or *Solid* Formations.

Series of "Tube Wells" can be coupled together, enabling Large Supplies of Water to be drawn from extensive areas.

No better system for Irrigation can be adopted, as the outlay is moderate and the results are obtained expeditiously.




Any kind of Surface Pumping Machinery and Power is adaptable.

These Tube Wells were extensively used in Abyssinia, Egypt, Mesopotamia, and by our Expeditionary Forces.

Also Artesian Bored Tube Wells.

All kinds of Pumping Machinery.

Registering Turnstiles.

1794

**C. ISLER & CO., Ltd.,** Artesian and Consulting Well Engineers, :: ::

ARTESIAN WORKS, BEAR LANE, SOUTHWARK STREET, LONDON, S.E. 1.

CONTRACTORS TO H.M. WAR OFFICE, ADMIRALTY, :: :: CROWN AGENTS, INDIA OFFICE, &c. :: ::

*Telegrams—"ISLER, LONDON."* *Telephone—HOP 4460 (3 lines).*

BIRMINGHAM: 58, SUMMER ROW. LEEDS: 210, WELLINGTON ST. And at LIVERPOOL



# 4 Million cubic feet of air per hour!

## PREMIER WET AIR FILTERS

This enormous quantity of air is being purified by Premier Air Filters, of which hundreds are in use by important firms all over the world.

Premier Wet Air Filters reduce overhead costs by lessening the risk of stoppage to machinery due to the presence of foreign matter in the air.

They also increase plant efficiency by reducing wear and tear on bearings and other working parts.

The air is cleansed and purified by being brought into contact with water in the form of Scotch Mist within the filter. Every impurity is removed from the air before it reaches the machinery.

*A few of the concerns who use Premier Wet Air Filters.*

Bolton Corporation.
Hong Kong Electric Supply.
Cardiff Corporation.
David Colville, & Sons.
Cory Bros.

*Full details of Wet and Dry Filters will be sent on application.*

**The PREMIER COOLER & ENG. Co., Ltd.,**
*Station Works,*
Shalford, Nr. Guildford, Surrey.

1428



# "Morse" High Speed Twist Drills

**Morse Maxims:**—We may take Fancy for a companion, but must follow Reason as our guide.—*"Dr. Johnson."*

The use of 18% Tungsten Steel;
The milling of the Helix angle;
The provision of proper lip clearance;
The Accurate grinding of the diameter;
—make these drills **highly efficient** tools **where Speed and Precision are needed.**

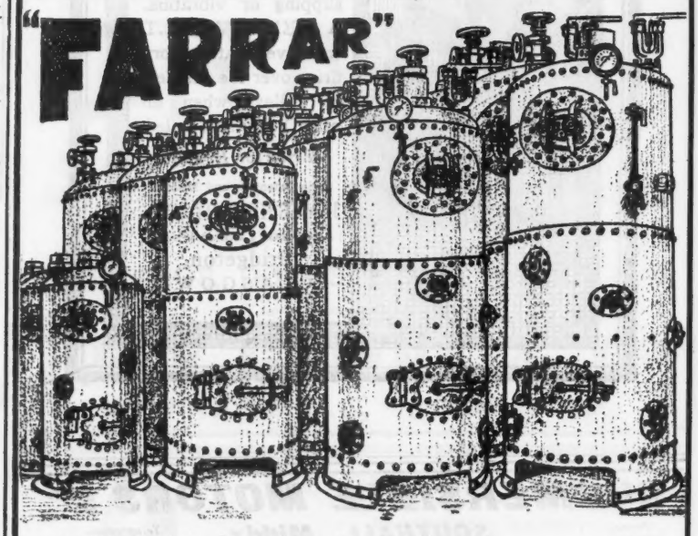
## BUCK & HICKMAN, LIMITED.

2, 4 & 6, Whitechapel Road, LONDON, E.1.

GLASGOW: 39, Robertson St. MANCHESTER: 62, Market St.
BIRMINGHAM: 23, Newton St. DUBLIN: Dame House, Dame St. 1353



# "FARRAR"



# IN STOCK

| | | | |
|---|---|---|---|
| 4 ... | 20 H.P. | ... | 13′ 0″ x 6′ 0″ |
| 2 ... | 16 ,, | ... | 12′ 3″ x 5′ 0″ |
| 3 ... | 12 ,, | ... | 10′ 3″ x 4′ 6′ |
| 3 ... | 9 ,, | ... | 9′ 0″ x 4′ 0″ |
| 3 ... | 8 ,, | ... | 8′ 6″ x 3′ 9″ |
| 4 ... | 6 ,, | ... | 7′ 6″ x 3′ 3″ |
| 2 ... | 4 ,, | ... | 6′ 9″ x 2′ 9″ |

All 100 lbs. W.P.

NOTE.
COMPLETE WITH MOUNTINGS TESTED FOR 100 LBS. PER SQ. INCH WORKING STEAM PRESSURE.

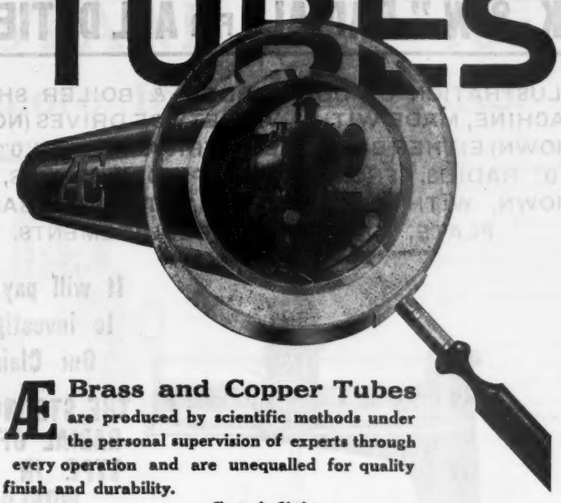
***For Prices Apply:—***

**THE FARRAR BOILERWORKS LTD.**

*Telephone: 61, NEWARK.*
*Telegrams: FARRAR, NEWARK.*

**NEWARK.** 935

# TUBES



**Æ Brass and Copper Tubes** are produced by scientific methods under the personal supervision of experts through every operation and are unequalled for quality finish and durability.

***Specialities :***

**"Koro"** Toughened Copper Locomotive Tubes have a world-wide reputation.

**Æ** Condenser Tubes, used extensively by British Admiralty and leading engineers all over the world.

Locomotive Plates, Locomotive Stays, Condenser Plates, etc.

***Established 1800.***

**Allen Everitt & Sons, Ltd.,**

Kingston Metal Works,
Smethwick, Birmingham. 1345

# De Laval

## OIL PURIFIER

ELECTRICALLY DRIVEN AND FITTED WITH PUMP FOR DELIVERING OIL TO THE MACHINE.

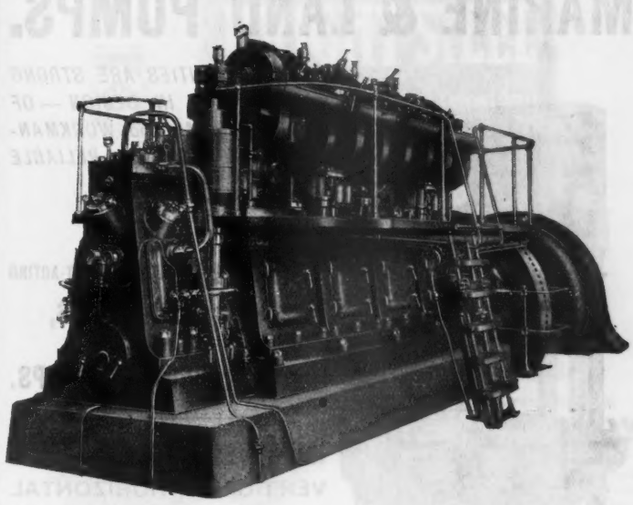
**Over 2,400 in use.**

The cost of the machine is recovered by the saving in Oil in a very short period.

Run a Purifier in conjunction with your Plant and thus assure the oil being kept in perfect condition.

The De Laval is the original Centrifugal Oil Purifier—a high efficiency machine backed by years of experience and flattered by imitators.

**DE LAVAL CHADBURN COMPANY, LTD.,** 1775
Wellington House, Buckingham Gate, LONDON, S.W.1.



# HICK DIESEL OIL ENGINES.

***The Most Economical Prime Mover for Electric Power, Oil and Water Pumping, &c.***

**SPECIAL FEATURES.**

Low Fuel Consumption.
Reliability for continuous heavy duty.
Ability to burn low grade fuels.
Standard sizes ranging from 50 to 1020 B.HP.
Open and Enclosed Types.

**Ready for immediate delivery :—**

300 B.HP. ... ... ... ... 175/187·5 R.P.M.

# HICK, HARGREAVES & CO., LTD.,

**BOLTON,** ESTABLISHED 1833. **ENGLAND.**

Telegraphic Addresses { "HICK, BOLTON." "UMSHAWVAPO, SOWEST, LONDON." Telephone Nos. { Bolton—1373 (3 lines). London—Victoria 7310

**LONDON OFFICE : 57, Victoria Street, S.W. 1.**

Telegraphic Codes : A B C, Fifth Edition ; A 1 (1888), Western Union (Universal Edition), Lieber's Standard.

1607

# MARINE & LAND PUMPS.

*OUR SPECIALITIES ARE STRONG and COMPACT IN DESIGN — OF BEST MATERIAL and WORKMANSHIP — EFFICIENT and RELIABLE IN SERVICE*

DAWSON FEED PUMP.

THE "DAWSON" PATENT DIRECT-ACTING
FEED PUMPS,
AIR PUMPS,
SERVICE PUMPS.

IMPROVED DUPLEX PUMPS
VERTICAL or HORIZONTAL
TO SUIT ALL PRESSURES.

MOTOR DRIVEN PUMPS
FOR
DIESEL ENGINES,
LAND STATIONS,
- MINE PUMPS. -

1100

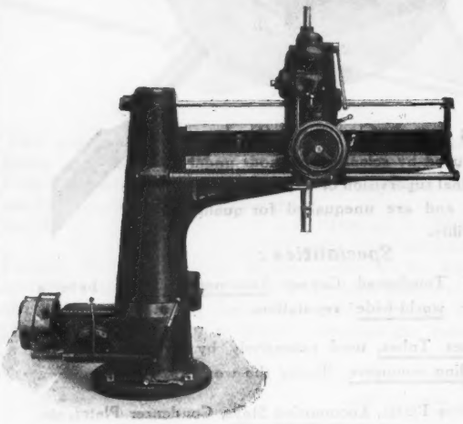
## DAWSON & DOWNIE, LTD.

Telegrams—"PUMPS, CLYDEBANK." CLYDEBANK. Telephone—93 & 93 CLYDEBANK



# "K. & W." RADIALS FOR ALL DUTIES.

ILLUSTRATION OF OUR GIRDER & BOILER SHOP MACHINE, MADE WITH A VARIETY OF DRIVES (NO. 4 SHOWN) EITHER BELT OR ELECTRICAL, FROM 4' 0" TO 8' 0" RADIUS. FROM 1 TO 8 SPINDLE SPEEDS, AS SHOWN, WITH BOX BED, OR WITH LOW BASE-PLATE, TO SUIT YOUR REQUIREMENTS.



It will pay you to investigate Our Claim.

THE STRONGEST RADIAL OF ITS TYPE IN THE WORLD.

May we send you full details?

GET A "K. & W."

1086

## KITCHEN & WADE,
Gibbet Street,
HALIFAX.

'Phone : 1673 HALIFAX.
Wire : KAW, HALIFAX.
Code : MARCONI INTERNATIONAL.



# A. F. SMULDERS, BOILERMAKERS

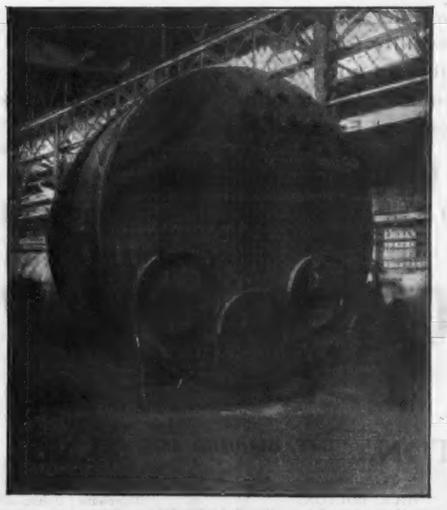
GRACE-BERLEUR-LEZ-LIEGE (BELGIUM).

LONDON AGENT—MR. ANDERSON RODGER,
*Tel. No. 3887 Victoria.* 38, VICTORIA STREET, WESTMINSTER, S.W. 1.

STEAM BOILERS OF ALL SYSTEMS AND POWERS. . . .
(MARINE—LOCOMOTIVE—INTERNALLY FIRED—MULTITUBULAR, ETC.)

MARINE BOILERS OF ALL POWERS, COMPLETE AND IN STOCK.

SCHEMES AND ESTIMATES ON APPLICATION.



ORDERS EXECUTED WITH CARE AND DESPATCH.

1541

## BRIDGES
AND CONSTRUCTIONAL ENGINEERING WORK OF ALL KINDS.
TANKS—PIT-HEAD FRAMES
RIVETED GIRDERS—CRANES—LIFTS, ETC.



# WORTHINGTON

*The Worthington is the Worthy Pump.*

Of all machines designed by the engineer the one that calls for the greatest trust—the one that must of necessity attain to the height of reliability and efficiency is essentially the pump.

Constant demand for good service has made the Worthington pump the outstanding example of maximum reliability.

*Write now for Catalogue Section EC. 75.*
*British Empire Exhibition, Wembley, 1924.*

PUMPS
CENTRIFUGAL PUMPS
CONDENSERS
COMPRESSORS
WATER WORKS PUMPING ENGINES
LOCOMOTIVE FEED-WATER HEATERS
CRUSHERS
OIL ENGINES
LIGHTING-SETS

686

PUMPS

75

## WORTHINGTON-SIMPSON LTD
QUEENS HOUSE KINGSWAY LONDON WC2
WORKS NEWARK AND LONDON
*Telephones Holborn 3048-3 lines - Telegrams Pumping Westcent London*

# STANDARD for more than 55 YEARS.

*Fig. 141.*
*I.B. Globe valves with yoke, gunmetal mounted, suitable for 150 lbs. working steam pressure.*

Architects and Engineers specify and recommend Jenkins Valves with the perfect confidence born of the knowledge that Jenkins Valves have been standard for more than 55 years. Every Jenkins Valve is strong and heavy, made of the best brass, iron or steel, and so proportioned that it will remain thoroughly dependable and unaffected when subjected to the strain of hard usage and continuous severe service.

Jenkins Valves are made to meet the requirements of all power plants, high and low pressure, heating service for buildings of every description, and for railways, steamships, etc. Write us for data on the valves in which you are interested, and ask for a copy of our

*72 page Catalogue FREE.*

Jenkins Valves

TRADE JENKINS MARK
Jenkins Bros

SINCE 1864

*JENKINS BROS. LTD.*

(DEPT. 1),
6, *GREAT QUEEN STREET, KINGSWAY, LONDON, W.C.* 2.
*Works:—MONTREAL, CANADA.* 1192



# BRIGHT STEEL

SUPER-FREKUT A NEW FREE CUTTING STEEL.

**OTHER HALESOWEN BRANDS.**

FREKUT. Ordinary rapid machining Steel. Prompt delivery in rounds, squares and hexagons of Standard sizes.

BRICOSHAFT. A high grade mild steel for shafting, piston rods, valve rods. Supplied up to 6" diameter in any length.

FIRBUS. Special Free-Cutting Case Hardening Steel.

*Your enquiries are solicited for the above and for Bright Steels of any specification.*

**"SUPER-FREKUT" is a new Free-Cutting Steel. Among the many advantages it possesses over other Free-Cutting Steels, is its comparative ductility. On test it gives an impact value of 20/30 foot pounds.**

**"SUPER-FRECUT," due to its rapid machining properties and uniformity, ensures big output from Automatic, Turret and Capstan Lathes.**

**"SUPER-FREKUT" is supplied in Rounds, Squares and Hexagons. Delivery of standard sizes can be made from stock.** 1766

## HALESOWEN STEEL CO., LTD.,

**HALESOWEN. NR. BIRMINGHAM.**



# BALL BEARINGS

**1886——37 YEARS EXPERIENCE——1923**

Ball Journal Bearings
Ball Thrust Bearings
Roller Journal Bearings
Steel & Metal Balls

**"Pioneers of the Industry"**

1767

## The Auto Machinery Co., Ltd.,

Telephone: 153 (2 lines).
Telegrams: Auto, Coventry.

**Coventry, Eng.**

Codes: Western Union, ABC (5th Edition).



WESTINGHOUSE

# WHAT A DIFFERENCE IT MAKES

IF THERE IS PLENTY OF HOT WATER AVAILABLE FOR WASHING ON A COLD WINTER'S DAY.

YOU CAN SECURE THIS ADVANTAGE WITHOUT HAVING TO INSTALL AN EXPENSIVE HEATING APPARATUS OR STORAGE TANKS.

Ask for our Booklet:—

**WARM WATER WITHOUT WAITING**

## The Westinghouse Brake & Saxby Signal Company, Ltd.

82, YORK ROAD, KING'S CROSS, LONDON, N. 1.

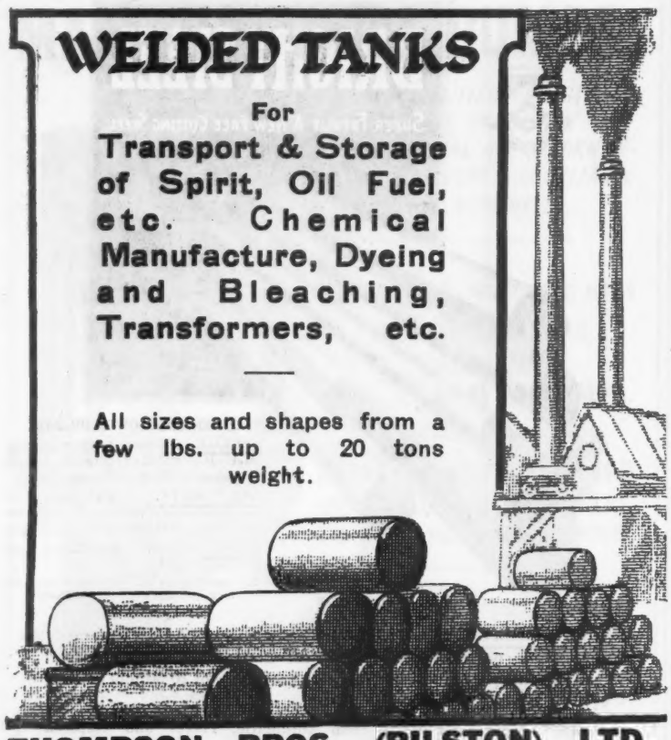
Telegrams: Westinghouse, Kincross, London. Telephone: North 2416.

1194

# WELDED TANKS

For
**Transport & Storage of Spirit, Oil Fuel, etc. Chemical Manufacture, Dyeing and Bleaching, Transformers, etc.**

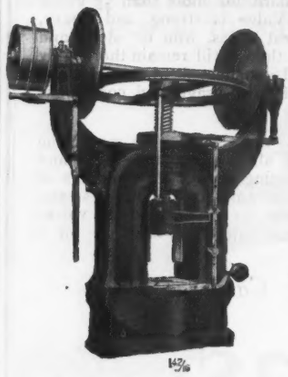
All sizes and shapes from a few lbs. up to 20 tons weight.



**THOMPSON BROS. (BILSTON) LTD.,**
Bradley Engineering Works, Bilston, Staffs.

1438

# POWER PRESSES



**POWER PERCUSSION SCREW PRESSES.**

FOR THE PRODUCTION OF
HOT BRASS PRESSINGS,
COLD STAMPINGS,
EMBOSSING, MARKING,
SHEET METAL WORK.

Made in 12 Sizes. Wide or Narrow Frame. Pressures from 12 to 440 Tons.

Fitted with Patent Automatic Ejector.

ALL KINDS OF PRESSES IN STOCK AND PROGRESS
for Blanking, Stripping, Drawing, Forming, Punching, &c.

*Our New Catalogue showing full range of Presses, &c., sent on application.*

'Phone: Central 3232 (2 lines).

JOHN HANDS & SONS LIMITED

Wire: "Machinery, B'ham."

**CARDIGAN WORKS, BIRMINGHAM.**

# Dirty Oil & Leakage wastes your Money

VALOR

OIL gone to waste from dripping taps and leaky containers runs up unnecessarily heavy bills by the end of the year. Apply the economy axe in the shape of these Valor specialities—the **Valor Oil Filter** and the **Valor Oil Cabinet.** They minimise the fire risk and eliminate pilfering, dirt and leakage.

Use your oil over and over again by efficiently filtering it through the
**VALOR Oil Filter.**
Cleans dirty oil rapidly. Made in several capacities.

Admitted to be the only perfect oil Storage System. The
**VALOR Oil Cabinet**
keeps oil sweet and sound. Made in 5 capacities–6-50 gallons.

**Both these articles save their initial cost in a very short time.**

*Prices on application. Ask for List 6.*

**THE VALOR CO., LTD.,**
Aston Cross, Birmingham.
London: 120, Victoria St., S.W.1.

9490

# DISSOLVED ACETYLENE

**Enables Acetylene to be used with atmospheric Air alone in Blowpipes on the Bunsen Principle.**

## Air-Acetylene for Soldering

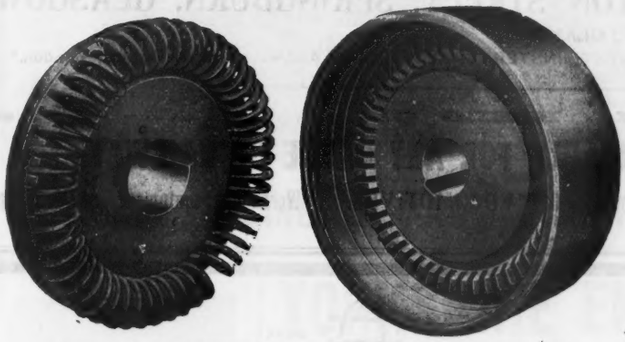
In the metal soldering process it is generally necessary to employ several soldering heads which are heated in turn in the stove. The use of the "A.-L." Soldering outfit entirely eliminates the need for more than one soldering head, which is supplied as a detachable part of the blowpipe. In the "A.-L." soldering blowpipe the temperature of the soldering head attached to the blowpipe is evenly maintained throughout the operation, and that at a negligible cost. The blowpipe can be used with any Dissolved Acetylene Apparatus.

1554

**Allen-Liversidge Ltd.**

**106, Victoria Street, WESTMINSTER, S.W. 1.**

# ELECTRO-METALS
# FLEXIBLE
# SHAFT COUPLINGS.



"UNION" PATENT FLEXIBLE SHAFT COUPLING.

If you require a shaft coupling to be reliable, to take up mal-alignment of shafting or to protect your machinery from severe shocks or strains, instal an Electro-Metals Flexible Type.

When sending enquiries state H.P. to be transmitted, R.P.M., and nature of drive.

## Boving Engineering Works Ltd.

*HEAD OFFICE:*
4, Broad Street Place, London, E.C. 2.
'Phone: 2477 London Wall.
*WORKS:*
Stoke-on-Trent. 1392

Steam and Electric
# CRANES, EXCAVATORS,
# WINDLASSES, WINCHES, CAPSTANS.

5 TON GRAB CRANE.

## JOHN H. WILSON & CO., LTD.
HEAD OFFICE AND WORKS: DOCK ROAD, BIRKENHEAD.
LONDON OFFICE: 15, Victoria Street, S.W. 1. 1595

# HYDRAULIC PUMPS ACCUMULATORS & PRESSES

DESIGNS REVISED THROUGHOUT
ENQUIRIES SOLICITED

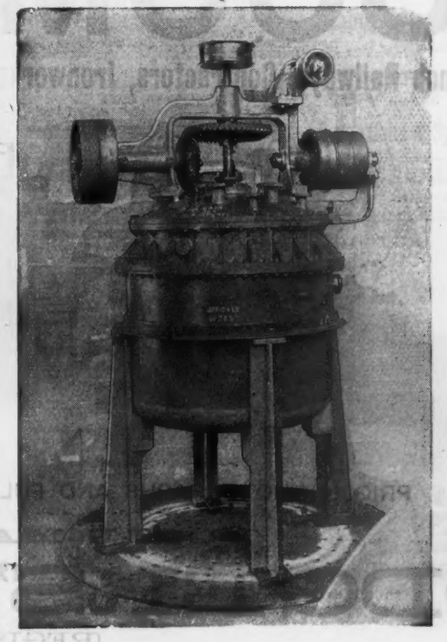
## West Hydraulic
ENGINEERING COMPANY LTD.
LUTON BEDS

*Telegrams: Hydraulic, Luton.* *Telephone: Luton 150.*

# THE BUTTERLEY CO., Ltd.
DERBY. ESTABLISHED 1719.
Telephone—Nos. 75 and 76 RIPLEY. Telegrams—"IRONWORKS, BUTTERLEY."

## PIG IRON, BAR IRON, IRON CASTINGS
Up to 20 Tons.

9560



**Bridge and Structural Steelwork, Pit Trams, &c.**

**High-class Machine Work of all descriptions.**

**Special Acid-Resisting Metal FOR Chemical Plants.**

**Large Retorts, Pans, Acid Eggs, &c., a Specialty.**

LONDON OFFICE: 82, Queen Victoria Street. Telephone—2180, City.

# NORTH BRITISH LOCOMOTIVE CO., LTD.,

HYDE PARK WORKS (Late NEILSON, REID & CO.) | QUEEN'S PARK WORKS (Late DUBS & CO.) | ATLAS WORKS (Late SHARP, STEWART & CO., Ltd.)

ADMINISTRATIVE BUILDING, 110, FLEMINGTON STREET, SPRINGBURN, GLASGOW.

Telegrams—"LOCO., GLASGOW."

Tel. No.: Victoria 6858. LONDON OFFICE: 13, VICTORIA STREET, WESTMINSTER, S.W.1. Tele. Address: "Hypar Sowest, London."

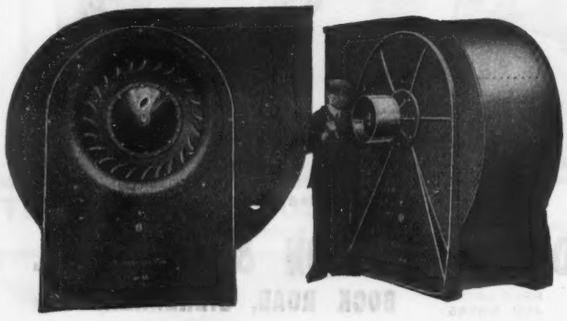
BUILDERS OF ALL KINDS OF 1389

**LOCOMOTIVE ENGINES AND TENDERS SUITABLE FOR ANY GAUGE OF RAILWAY.**

Annual Capacity, 800 MAIN LINE LOCOMOTIVES. Output now exceeds 23,000 LOCOMOTIVES. Workshops equipment, 8000 MEN.

FOR ALL PURPOSES.

TRADE MARK.



# FANS & BLOWERS

STANDARD & OSWALD STOTT (Engineers), LTD.,

Telegraphic Address: "BLOWING, LEICESTER." Evington Valley Road, LEICESTER. Telephone Nos.: 4761-2-3 LEICESTER.

MANCHESTER - GLASGOW - NEWCASTLE-ON-TYNE.

20 years' experience is at your service for the asking. 1346

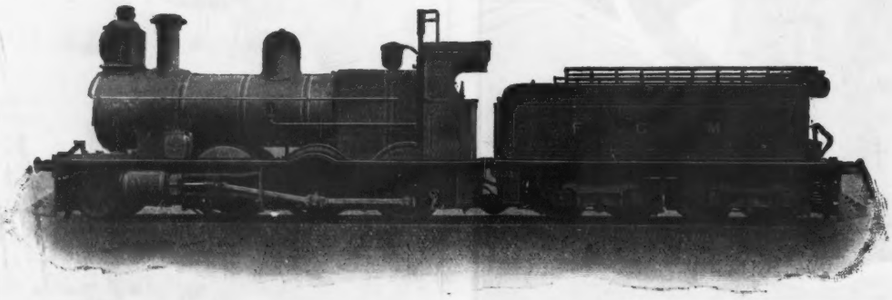
# HUDSWELL, CLARKE & CO., LTD.,

RAILWAY FOUNDRY, LEEDS.

# LOCOMOTIVES

For Main or Branch Railways, Contractors, Ironworks, Collieries, &c. Made to suit any Gauge of Railway.

Established 1860.



Telegraphic Address: "LOCO, LEEDS."

PRICES, PHOTOGRAPHS AND FULL SPECIFICATIONS ON APPLICATION. 1112

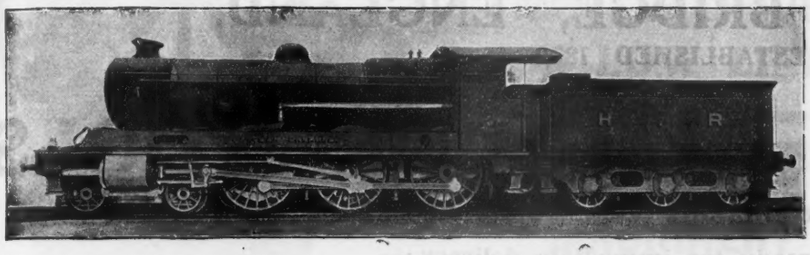
SOLE MAKERS OF

# "RODGERS' PULLEYS"

(REGISTERED).

*WROUGHT IRON THROUGHOUT, RIM, ARMS, AND BOSS.*

# R. & W. HAWTHORN, LESLIE & CO., LTD.



## LOCOMOTIVES

Of every description for Home and Foreign Railways.

**TANK ENGINES AND COMBINED CRANES AND LOCOMOTIVES**

ALWAYS IN STOCK AND IN PROGRESS.

*For Collieries, Ironworks, Railway Depots, Branch Lines, Contractors, &c.* 1123

Telegraphic Address: LOCOMOTIVE, NEWCASTLE-ON-TYNE ESTABLISHED 1817.

**MARINE ENGINEERS AND SHIPBUILDERS.** **NEWCASTLE-ON-TYNE.**

# YORKSHIRE ENGINE CO., LTD.,

*Head Office:* MEADOW HALL WORKS, SHEFFIELD.

*Contractors to Admiralty, War Office, India Office, Colonial and Foreign Governments, and Leading Shipbuilders.*

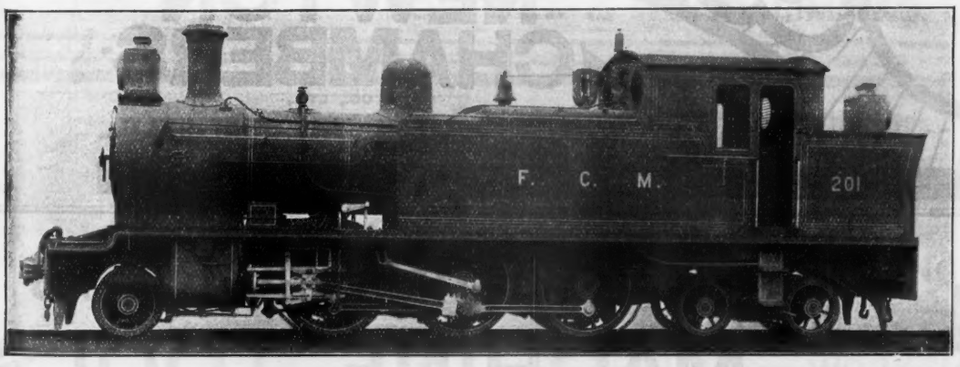
**LOCOMOTIVES OF ANY GAUGE OR WEIGHT.**
**IRON & STEEL FORGINGS. WELDLESS STEEL RINGS.**
**SHIP & ENGINE DETAILS. W.T. SLIDING SCUTTLES,**
**SOLID & BUILT-UP CRANKSHAFTS. PROPELLER SHAFT NUTS.**
**WATERTIGHT DOORS. CRANE POSTS & HOOKS.**
**BOAT DAVITS. RUDDER POSTS & PINTLES.**
**ELECTRIC WINCHES. GENERAL MACHINE WORK.**
**COMPLETE SETS OF ENGINE SHAFTING.**

*Telegrams:—ENGINE, SHEFFIELD. Telephones:—129 & 130 Attercliffe.* 1137

*London Office:* 83, BUCKINGHAM PALACE ROAD, WESTMINSTER, S.W. 1.
*Telephone No. Victoria 7674.*

# THE HUNSLET ENGINE CO., Ltd.,

## LEEDS.




MAKERS OF 1176

## LOCOMOTIVE ENGINES

**Adapted to every variety of work and gauge.**

***DESIGNS & SPECIFICATIONS SUPPLIED OR WORKED TO.***

**Quotations & Specifications on application.**

Telegraphic Address: "ENGINE, LEEDS."
Telephone:—Nos. 20877 (2 lines).

# PECKETT & SONS, LTD.,

## BRISTOL.

Telegrams - - - Peckett, Bristol

**SPECIALITY**

# TANK LOCOMOTIVES

**Of all Descriptions and any Size or Gauge.**

***Full Particulars on Application.*** 9989

# FRANCIS BERRY & SONS,

## SOWERBY BRIDGE, ENGLAND.

**ESTABLISHED 1832.**

# MAKERS OF MACHINE TOOLS

**for Shipbuilders, Boiler Makers, Constructional Engineers, etc.**

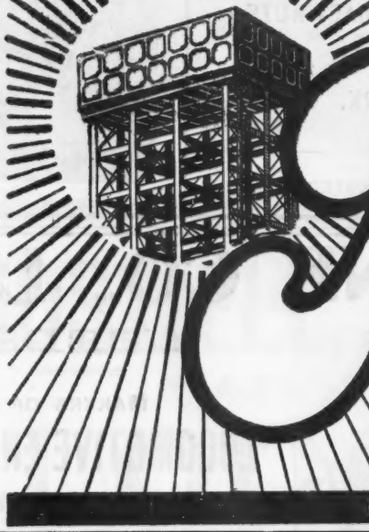
**First-class Machines, finished to stock, ready for immediate delivery :—**

One 1 in. by 1 in. by 24 in. Punching, Shearing and Angle [Shearing Machine.
One $\frac{7}{8}$ in. by $\frac{7}{8}$ in. by 20 in. Do.
One $\frac{5}{8}$ in. by $\frac{5}{8}$ in. by 18 in. Do.
One 12 in. by 6 in. Beam Bending Machine.
One 9 in. by 4 in. Do.
One 6 in. by 4 in. Do.
One 8 ft. 0 in. by $\frac{5}{8}$ in. Plate Bending Rolls.
One 1 in. "Doxford's" Patent Joggling Machine.
One $\frac{5}{8}$ in. Plate Splitting Shears.
One 10 ft. 0 in. Plate Edge Planer.
One 26 ft. 0 in. Plate Edge Planer with hydraulic rams.

***Kindly favour us with your enquiries.***

1184

IN CAST IRON OR STEEL



# Tanks

**NEWTON CHAMBERS & CO., LTD.,**

**THORNCLIFFE NEAR SHEFFIELD.**

OF ALL SIZES FOR ALL PURPOSES.

1190

ILLUSTRATION OF 14 in. SLOTTING MACHINE

# FOR HIGH CLASS MACHINE TOOLS

Send your enquiries to

## Noble & Lund, Ltd.,

**Felling-on-Tyne.**

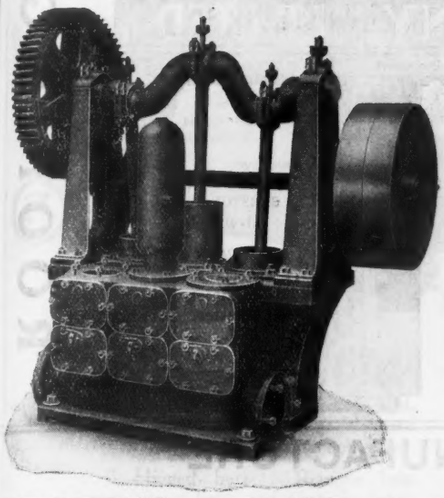
Specialists in Planing Machines.
" " Cold Sawing Machinery.
" " High Speed Friction Saws.
" " Lathes.
" " Drilling and Boring Machines.
" " Slotting and Shaping Machines.

1188

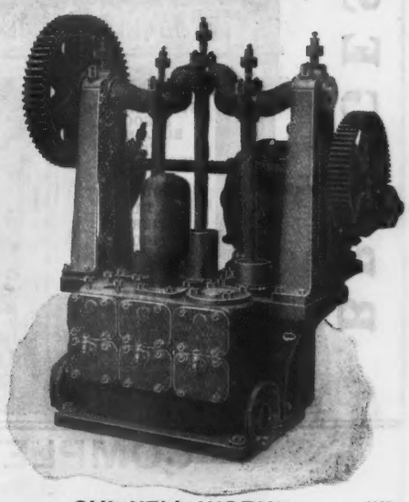
# VERTICAL THREE-THROW PUMPS

*for* BELT AND MOTOR DRIVE.

**FOR LOW LIFTS.**



**PUMPS AND PUMPING MACHINERY FOR EVERY PURPOSE.**



*Write for List No. 3.*

**JOSEPH EVANS & SONS (WOLVERHAMPTON) LTD.** CULWELL WORKS, **WOLVERHAMPTON.** 1188

# HASLAM'S

Ammonia & $CO_2$ Compression Systems
Ammonia Absorption, Compressed Air

# REFRIGERATING MACHINERY

FOR COLD STORAGE, ICE-MAKING, &c., ON SHIPBOARD AND ASHORE

541-3, SALISBURY HOUSE, LONDON WALL, LONDON, E.C. 2.

**THE HASLAM FOUNDRY & ENGINEERING CO., LIMITED,**
INCORPORATED WITH
**PONTIFEX & WOOD, LIMITED.**

UNION FOUNDRY, DERBY. 01445
*Telegrams—ZERO DERBY.*

BASCULE BRIDGE, RAISED.

**BRIDGES** of all types for Railways, Road or Foot, designed, constructed and erected, including foundations.

STEEL FRAME BUILDINGS.

PIERS—JETTIES—DOCK GATES.

WAREHOUSES — WORKSHOPS — CAISSONS.

**CRANES** FOR DOCKS — HARBOURS AND WHARVES. SPECIAL CRANES FOR STEELWORKS AND SHIPYARDS.

PUBLIC WORKS CONTRACTORS and SPECIALISTS IN REINFORCED CONCRETE.

**SIR WILLIAM ARROL & CO., LTD.,** DALMARNOCK IRONWORKS, **GLASGOW.**

(Agents in New Zealand:—MESSRS. CORY-WRIGHT & SALMON, WELLINGTON, N.Z.). 1424

BRIDGES

FRANCIS MORTON AND COMPANY LIMITED

ROOFING

STEEL BRIDGE & ROOF BUILDERS.
STEEL WORKSHOPS.
CRANE GIRDERS.
OIL TANKS.
PIERS.
IRON CASTINGS.
PRESSED STEEL GUTTERS.
RIVETTED STEEL TELEGRAPH POLES.

BRIDGE SPAN FOR CHINESE RAILWAYS.
— ERECTED IN OUR BRIDGE SHOP. —

*Head Office and Works:*
Hamilton Ironworks, GARSTON, Liverpool.

*London Office:*
17, Victoria Street, Westminster, S.W.

1254

COMPLETE PLANT FOR MANUFACTURE

OF

# PORTLAND CEMENT

ON

1764

THE LATEST AND MOST ECONOMICAL SYSTEMS

**Wm. JOHNSON & SONS (LEEDS) LTD. ARMLEY, LEEDS.**

# DROP FORGINGS

FOR THE ENGINEERING TRADES MADE IN

**STEELS** to any analysis, special attention being paid to the heating and working of Carbon, Nickel, Nickel Chrome, Chromium, Chrome Vanadium and other Alloy Steels.

**HEAT TREATMENT** carried out under the direct supervision of our laboratory to meet all Engineering Standards Committee, Air Board, Admiralty, War Office, and other Specifications and Tests.

1536

SEND YOUR ENQUIRIES TO-

**The Smethwick Stamping Company, Limited,**

BRIDGE STREET, SMETHWICK.

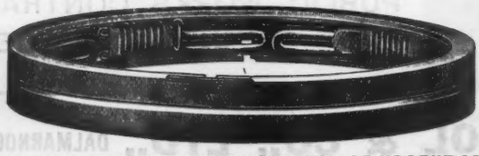
# LOCKWOOD & CARLISLE, Ld.

**EAGLE FOUNDRY, SHEFFIELD.**

Telegraphic Address: "PISTON, SHEFFIELD." National Telephone: 1376.

**Improved Double-action Metallic Piston Packing Rings & Springs.**

CARLISLE'S PATENTS.



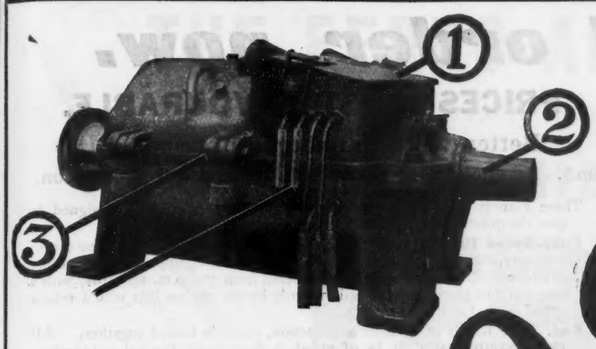
1504

*SPECIAL FACILITIES FOR QUICK DESPATCH OF URGENT ORDERS.*

Improved Double-action Piston Valve Rings.

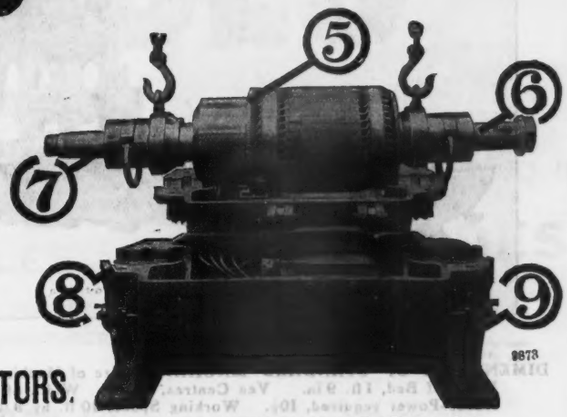
***As Fitted in S.S. "BRITANNIC."***

H.P. Rings and Springs specially designed for High Steam Pressures.




# 9 Points of Interest to Engineers.

1. Extra large dust-proof inspection cover.
2. Shaft extended each end. Machine interchangeable end for end using same bolt holes.
3. Hinged here. Remove four joint bolts and hinge back top half of yoke. See opposite.
4. All joints external. No internal connections to break when opening machine.
5. Commutator bars and lugs in one solid piece.
6. Heavy shaft of special nickel steel.
7. Split bearing bushes. Large bearing surface.
8. Wide machined joints.
9. Large oil wells.




E C C

HEAVY DUTY
"STEEL WORKS" MOTORS.

## THE ELECTRIC CONSTRUCTION CO., LTD.,

Head Office:
INGERSOLL HOUSE, 9, KINGSWAY, LONDON, W.C. 2.

Works:
WOLVERHAMPTON.

Exhibitors in the Electrical and Allied Engineering Section, British Empire Exhibition, 1924.

# SCIENTIFIC TESTING

THIS MACHINE IS OF THE VERTICAL TYPE AND IS "UNIVERSAL" IN CHARACTER, PERMITTING DIFFERENT FORMS OF TEST TO BE MADE WITHOUT CHANGE OF TOOLS.

IT IS DESIGNED UPON THE SINGLE LEVER PRINCIPLE, THE LOAD UPON THE TEST PIECE BEING INDICATED BY A POISE WEIGHT TRAVERSING A GRADUATED SCALE UPON THE STEELYARD.

THE STEELYARD IS GRADUATED FROM ZERO TO 50 TONS, THE FINEST SUB-DIVISIONS BEING ·001 TON.

THE LOAD IS APPLIED BY AN HYDRAULIC CYLINDER AND RAM, WHICH MAY BE CONNECTED DIRECT TO PURCHASER'S HYDRAULIC SUPPLY, OR THE MACHINE MAY BE FURNISHED COMPLETE WITH A MOTOR-DRIVEN VARIABLE CAPACITY PUMP, THUS RENDERING THE WHOLE TESTING UNIT SELF-CONTAINED.

THE MOVEMENT OF THE POISE WEIGHT AND THE FINE SPEED REGULATION OF THE HYDRAULIC SUPPLY ARE UNDER EASY CONTROL OF THE OPERATOR WHO CAN CONDUCT THE TEST THROUGHOUT WITHOUT A CHANGE OF POSITION.

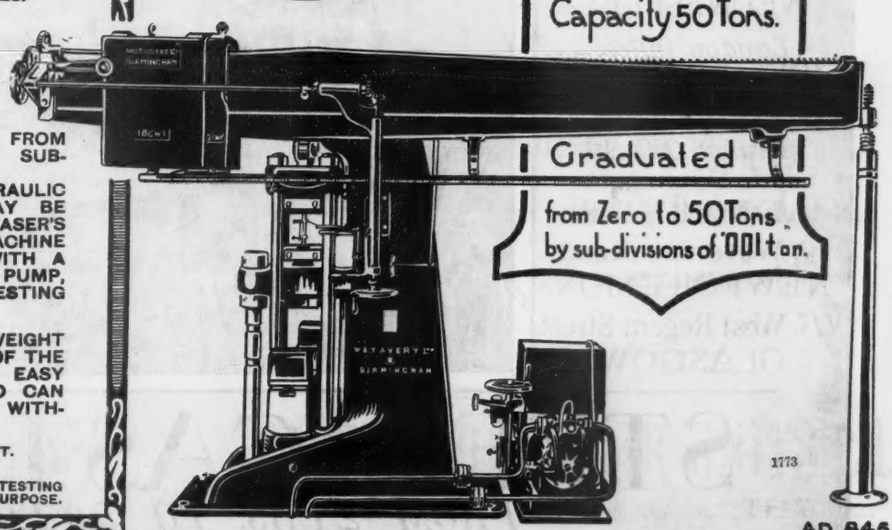
WRITE TO-DAY FOR LIST 78 TO T.M. DEPT.

W. & T. AVERY LTD.

MANUFACTURERS OF WEIGHING, COUNTING AND TESTING MACHINES OF EVERY DESCRIPTION, FOR EVERY PURPOSE.

AVERY

THE
No. 618 AVERY
UNIVERSAL
TESTING
MACHINE.
Hydraulic Type.
Capacity 50 Tons.




AD 846

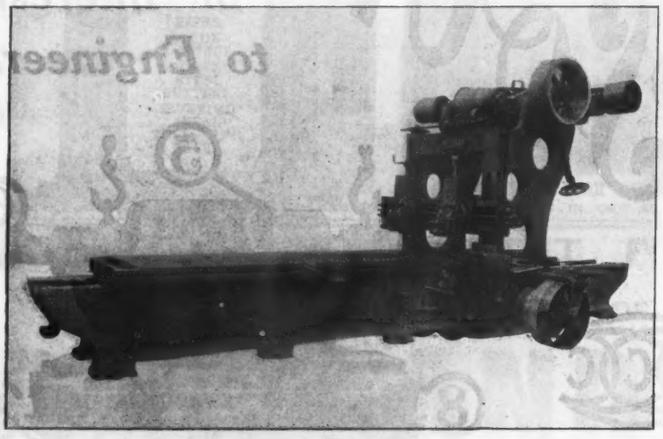
W. & T. AVERY LTD SOHO FOUNDRY BIRMINGHAM

# Why you should order now.

**DELIVERY FROM STOCK.** **PRICES MOST FAVOURABLE.**

**Don't be caught when prices are advancing.** **Better value cannot be obtained.**

**In the front rank of Planer builders for the past 30 years and still going strong.** **An opportunity to cut costs and speed up production.**



These Planers embrace our very latest improvements, and are designed to give the greatest output possible with a belt drive.

**Four-Speed Drive (self-contained).** An absolute essential feature of economy, showing a greater saving in time when so equipped, than any other machine tool. Any cutting speed desired from 30 f.p.m. upwards, with a range of 2 to 1, can be obtained instantly by the endless belt with a return speed up to 120 f.p.m.

**Bed.** The bed is of massive construction, strongly braced together. **All the gearing, which is of steel,** is fitted inside the bed and carefully protected from dirt and grit.

The gearing operating table has **double helical teeth** up to Bull Wheel Pinion.

**Pulleys. The driving pulleys are of aluminium to reduce momentum,** thus enabling the belts to pick up quickly on the reversals.

**Table.** Of heavy section and further strengthened by both longitudinal and transverse ribs preventing deflection under heavy cuts. Tee slots are planed out of the solid.

**Cross-slide.** Of double box section, to enable it to withstand the heaviest cuts, and firmly clamped to the uprights by means of bolts and plates.

**Toolboxes.** These are self-acting under all cuts, whether horizontal, vertical or angular, and made to travel in either direction.

**Side Tool Boxes.** Are fitted with extra heavy long slide to enable jobs to be machined which require considerable overhang of the slide.

**Rise and Fall to Cross-slide.** An improved friction clutch, enabling the operator to instantly start and stop without any jar, so that the cross-slide can be adjusted to fine limits.

A machine of this design can be seen in actual operation at our Works.

**DIMENSIONS OF STANDARD MACHINE.**—Size of Machine, 3 ft. by 3 ft. by 8 ft. Length of Table, 8 ft. between pockets. Length of Bed, 13 ft. Depth of Bed, 1 ft. 9 in. Vee Centres, 21 in. Width of Table, 32 in. Length of Down Feed, 12½ in. Face of Rack and Bull Wheel, 4 in. Horse-Power required, 10½. Working Space, 10 ft. by 9 ft. Approx. Net Weight, 7 tons.

## C. REDMAN & SONS, LTD.,

**Planer & Lathe Specialists,**

**KINGSTON, HALIFAX.**

Telephone 808.
Telegrams and Cables:
"PLANERS, HALIFAX."

1232

CODES: LIEBER'S (5 LETTER). A B C (6th EDITION). MARCONI INTERNATIONAL.

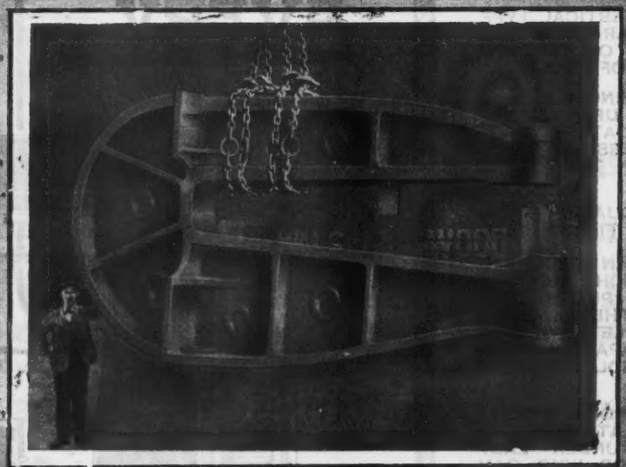
# F. H. LLOYD & Co., LTD.

## JAMES BRIDGE STEEL WORKS, NEAR WEDNESBURY.

*Head Office:*
James Bridge Steel Works,
WEDNESBURY.

*London Office:*
50, Queen Anne's Gate,
WESTMINSTER, S.W.1.

*Branch Offices:*
134, Deansgate,
MANCHESTER.
19, Waterloo Road,
NEWPORT, MON.
143, West Regent Street,
GLASGOW.



On Admiralty Lloyds Register & Crown Agents for the Colonies Lists

*Telegrams:*
STEEL, DARLASTON
SAEPIUS, VIC, LONDON

*Telephone:*
44 DARLASTON
1361 VICTORIA

# STEEL CASTINGS

## FROM 2 LBS. TO 20 TONS.

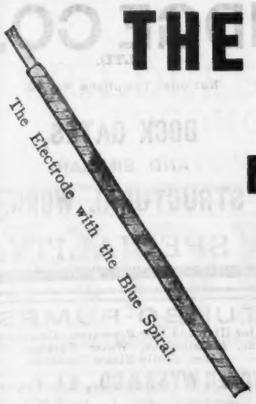
*The quality of our Castings is the outcome of 40 years' experience. You can be supplied from open Hearth or Tropenas Furnaces with all types of Castings which from start to finish have the benefit of a plant which has been kept up to date. Give us the privilege of quoting you.*

1861

# THE FERRO-ARC WELDING CO., LTD.,

HAVE NOW PUT ON THE MARKET THEIR

## NEW CHEAP ELECTRODES




# FERRODES

PRICE NO. 8 GAUGE 60/- PER 1000 FEET.

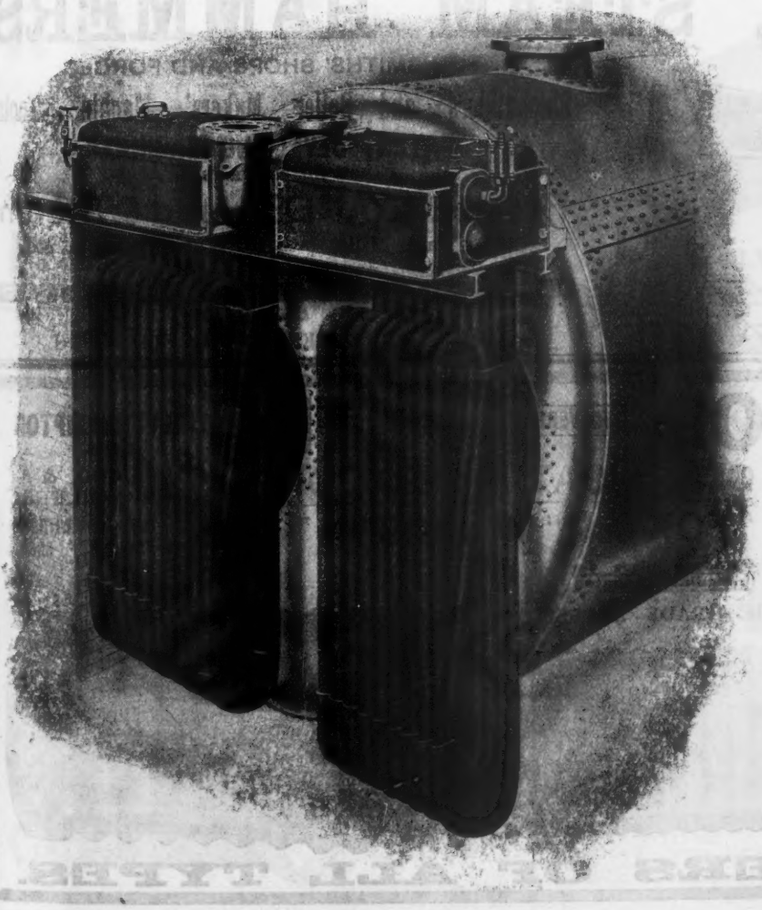
WELDS MADE WITH FERRODES SHOW A TENSILE STRENGTH OF OVER 24 TONS PER SQ. IN

**FERRODES**
CAN BE USED WITH
AC OR DC
AND ON ANY
STANDARD WELDING SET.

**FREE SAMPLES**
WILL BE SENT TO YOU ON RECEIPT
OF A POST CARD BY THE MANUFACTURERS.

THE FERRO-ARC WELDING CO., LTD.,
12, GROSVENOR GARDENS,
LONDON, S.W. 1.

**FERRODES**
ARE THE
CHEAPEST
FLUX COVERED
ELECTRODES
ON THE MARKET.



# "UNIT" SUPERHEATERS

The most efficient and accessible Superheater on the Market.

Every tube element is detachable.

All parts are interchangeable.

HEAD OFFICE:
SUPERHEATER UNITS Ld.
4, Castle Square, SWANSEA.
WORKS: 1657
UNIT WORKS, STRAND, SWANSEA.
INKERMAN WORKS - SWANSEA.

**Wrights**
**STEEL WIRE ROPES**
Locked Coil, Flattened Strand, Round Strand Etc.
See illustrated advertisement page 39, Dec. 14. 1498

**W. G. BAGNALL, Ld**
**STAFFORD**
**BUILDERS OF LOCOMOTIVES**
Weighing from 3 to 50 tons, for any gauge of Highest-Class Workmanship and Materials.
MAKERS OF 1596
Tipping Trucks. Sugar Cane Wagons. Turntables, Switches, &c.
See Illustrated Advert. page 94.

**COCHRANE**
**"CLYDE" PUMPS**
FOR
WATERWORKS,
SEWAGE WORKS,
CONDENSERS,
DISTILLERIES,
MARINE CIRCULATING,
MINES, ETC.
*Illustrations and full particulars can be obtained on application.*
**JOHN COCHRANE (BARRHEAD) LIMITED,** 9928
BARRHEAD, NEAR GLASGOW.
ESTABLISHED OVER 70 YEARS.

**THE MOTHERWELL BRIDGE CO. LTD.**
MOTHERWELL, N.B.
Telegraphic Address—"BRIDGE." National Telephone No. 40.

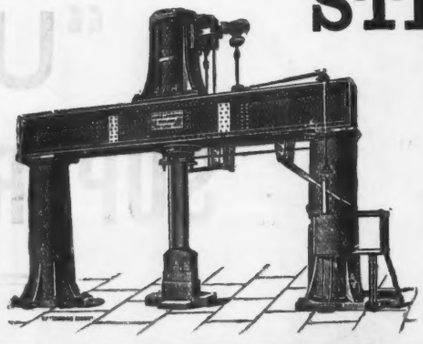
BRIDGES, ROOFS, PIERS, TANKS,
DOCK GATES, AND SIMILAR STRUCTURAL WORK. 1691
HYDRAULIC PRESSED FLOORING A SPECIALITY.

**STEAM LAUNDRY MACHINERY.**
D. & J. TULLIS Ld.
Clydebank, N.B.
See our Advert. page 91, Dec. 14. 1660

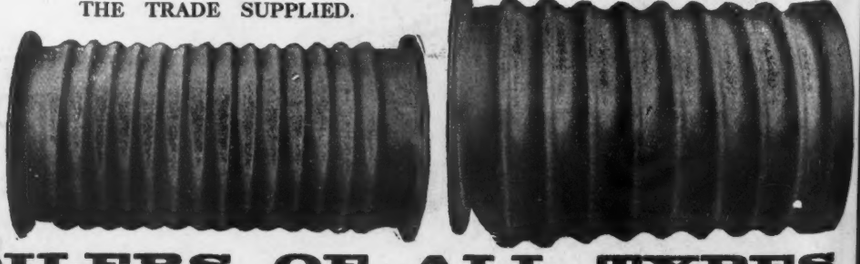
**JACK'S CRANES**
ALEXANDER JACK & Co., Ltd.,
Whitegates Works,
Motherwell, Scotland. 689
See Illustrated Advertisement every fourth week.

**TURBO-PUMPS**
for High and Low Pressures. Complete Hydr. Installations, Water Turbines, Pipe Lines, Zoelly Steam Turbines. 1431
**ESCHER WYSS & CO., S.A.,** Engineers,
20, Grosvenor Gardens, London, S.W.1. 48/23
Tel.: Vic. 9120. Tele: Hswysco-Sowest Lon.

**E. J. SMITH & CO. (Metals) LTD.**
IF you want the correct Metal Mixture for any special job, we invite you to take advantage of the experience and assistance of our highly skilled technicians and laboratory specialists, which is offered *without any extra charge.*
Send us your orders for Ingot Metals—our prices are keen and we guarantee Prompt Delivery for any quantity.
**E. J. SMITH & CO. (Metals) LTD.,**
**TYSELEY METAL WORKS, BIRMINGHAM.**
*Phone: Victoria 584.* *Wires: "Tysefermo, B'ham."*
London Office: Balfour House, Finsbury Pavement, E.C.2.
*'Phone: 3430 and 3431 Clerkenwell.* 1059
Manchester Office: Cleveland Buildings, 94, Market Street.


**STEAM HAMMERS**
FOR SMITHS' SHOPS AND FORGES
Shipbuilders' and Boiler Makers' Machine Tools.
**PATENT BEVELLING MACHINES**
FOR SHIPS' FRAMES.
FORGE CRANES, Hand & Steam.
Sugar Cane Mills. Water Wheels, &c.
**DAVIS & PRIMROSE,**
*Limited,* 1188
BANGOR WORKS. LEITH. EDINBURGH.

**JOHN THOMPSON (WOLVERHAMPTON) LTD.** WOLVERHAMPTON ENG.
"JOHN THOMPSON" BOILER
(With Dished Ends and Corrugated Flues.)
IMMEDIATE DELIVERY
4 30 ft. × 9 ft. 3 in. × 160 lbs. W.P.
2 30 ft. × 9 ft. 3 in. × 120 lbs. W.P
2 30 ft. × 8 ft. 6 in. × 120 lbs. W.P
2 30 ft. × 8 ft. 6 in. × 160 lbs. W.P.
4 30 ft. × 8 ft. 3 in. × 100 lbs. W.P
1 28 ft. × 7 ft. 6 in. × 120 lbs. W.P.

CORRUGATED SECTIONS (FOR LAND & MARINE BOILERS.)
"FOX" OR "MORRISON" TYPE WITH OR WITHOUT "GOURLAY" ENDS.
9406
Standard Sizes for Immediate Despatch
THE TRADE SUPPLIED.

**BOILERS OF ALL TYPES.**

# TUBES LIMITED

WELDLESS TUBES for BOILERS and STEAM PIPES
LOCOMOTIVES & THE ENGINEERING & MOTOR TRADES.

Works: ASTON MANOR, BIRMINGHAM. 3651 Tele{gram: Cylinders, phone: No. 871 & 872 E (4 lines).

# HOLMAN AIR COMPRESSORS.

HOLMAN BROS., LTD., CAMBORNE, ENG. London Office: Broad St. House, E.C.2.

# FOSTER BROTHERS LIMITED.

LEA BROOK WORKS, WEDNESBURY.

STEAM AND OTHER PIPE RANGES
SUPPLIED OR ERECTED COMPLETE.

THE PATENT LIGHTNING

# CRUSHER & PULVERIZER

The Best on the Market for reducing hard materials such as Flint, Shingle, Gravel, Silica, Magnesite, Barytes, etc.; also Limestone, Chalk, etc.

TELEGRAMS: "AGENCIADOR, LONDON."
TELEPHONE:— 4656 CITY.

*Invaluable for CONCRETE and BUILDING SAND.*

THE PATENT LIGHTNING CRUSHER CO., Ltd., 7174 14a, Rosebery Avenue, LONDON, E.C.

# ROLLS

CHILLED AND GRAIN

AND CASTINGS UP TO 20 TONS.

ALSO

IRON & STEEL BARS,
Rounds, Squares, Flats, Tees, Angles, Numerous Sections,
BOLTS & NUTS, &c.
IRON FENCING & GATES, &c.

CATALOGUE FREE.

BAYLISS, JONES & BAYLISS, LTD., WOLVERHAMPTON AND LONDON, E.C. 4.

## *VARIETY.*

WILLIAMS' line of Superior Drop-Forged Wrenches offers the greatest variety made by any one manufacturer—45 patterns in about 1000 sizes; a standard wrench for every purpose.

WRENCH BOOK ON REQUEST.

J. H. WILLIAMS & CO.,
*"The Wrench People."*

Export Office: 21, State Street, New York, U.S.A.
London Representative: BENJ. WHITTAKER, Ltd., 56, Ludgate Hill, London, E.C.4. Joint Stocking Distributors for Great Britain: Messrs. BUCK & HICKMAN, LTD.
General Offices: 400, Vulcan Street, Buffalo, New York, U.S.A.
759

**Rd. White & Sons, Widnes,** FOR **RAILS,** Lancs. 1636
POINTS AND CROSSINGS.
*AERIAL ROPEWAYS.*

**MAXWELL & FAGE,**
(Successors to BRUCE & STILL, LTD.)
*49, Sefton Street, LIVERPOOL.*
CONSTRUCTIONAL ENGINEERS & CONTRACTORS
for Steel Buildings, Bridges, Girders, and all descriptions of Structural Work. Timber Buildings designed for use at home & abroad.
*See Illustrated Advert. Preceding & Following Weeks.*
Catalogues, Designs & Estimates on application 1626
Tels.: No. 1317 Royal. Telegrams: "Galvanizer," Liverpool

REFRIGERATING MACHINERY
COLD STORAGE & ICE MAKING PLANT
H. J. WEST & CO., Ltd.
72-74 Grays Inn Rd., London, W.C.1

CENTRIFUGAL **PUMPS** & HIGH SPEED ENGINES
BON ACCORD
SEE OUR LARGE ADVT IN LAST WEEK'S ISSUE.
DRYSDALE & Co Ltd YOKER. GLASGOW W.

**MAVOR & COULSON LTD**
DYNAMOS · MOTORS · SWITCHGEAR
47 BROAD ST · MILE END · GLASGOW

**CLIFTON & BAIRD, Ld.**
Metal Sawing Machine Specialists,
EMPRESS WORKS, 1969
JOHNSTONE, SCOTLAND.

AUTOMATIC REGULATORS
**ARCA** FOR ALL PURPOSES 1876
See next week for displayed Advt.
BRITISH ARCA REGULATORS LTD.
WINDSOR HOUSE, VICTORIA STREET, S.W.1.

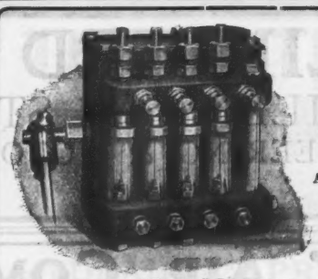
**TURNED TAPER PINS.**
LION ENGINEERING Co., LTD.
GRANVILLE STREET—BIRMINGHAM.
*Telegrams* 1606 *Lionengco, B'ham.* *Telephone:* *1643 Midland.*

**CROSBY SPECIALITIES.**
SEE ADVERTISEMENT NEXT WEEK.
CROSBY VALVE & ENGINEERING Co., Ltd.
41-42, FOLEY STREET, LONDON, W.1

**A. F. CRAIG & CO., LTD.**
Paisley. 1613
*Engineers & Boilermakers.*
See our half-page advertisement, Nov. 23.

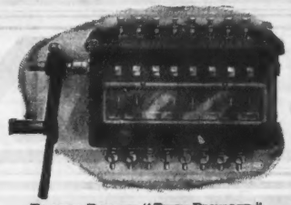
BRICK MAKING MACHINERY
**Herbert Alexander & Co Ltd**
Charmouth St.
LEEDS.

**MICHELL BEARINGS, LD.,**
ENGINEERS and MANUFACTURERS OF
Michell Thrust & Journal Bearings.
London Office: 1749
3, Central Buildings, Westminster.
See large Advertisement, page 106, Dec. 21



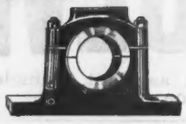
**"EMPIRE"**
FORCE-FEED
**LUBRICATORS**
for DIESEL and other ENGINES.
MADE IN ANY NUMBER OF FEEDS.
Also makers of the "Victor," "Trusty," "Feedwell," "Surefeed," and other Force-Feed Lubricators.

EMPIRE PATENT "DIRECT" LUBRICATOR.

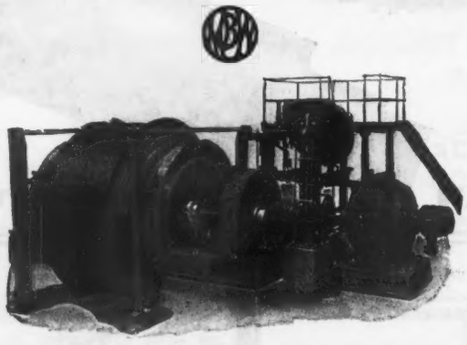


**EMPIRE ENGINEERING CO.**
(MANCHESTER) LTD.
EMPIRE WORKS,
Salford, MANCHESTER.
EMPIRE PATENT "TWIN-PLUNGER" LUBRICATOR. 1258

**PLUMMER BLOCKS**
OF EVERY DESCRIPTION & SIZE



**SELF-OILING PLUMMER BLOCKS A SPECIALITY.**
*Write for New Illustrated Catalogue with Details and Prices.*
HENRY CROWTHER & SONS, LTD.
CLECKHEATON, YORKSHIRE.



IF YOU ARE CONSIDERING
**ELECTRIC WINDING**
——send us your enquiry and make the first sound step.
You will thereby ensure correct design and efficiency in every detail most economically meeting your own particular requirements.
Ask for List No. 22 C, illustrating recent installations.
**M.B.WILD & CO. LTD.**
NECHELLS, BIRMINGHAM.
TELEPHONE: BIRMINGHAM EAST 208. CODES: A.B.C. (5th Ed.) LIEBER'S & BENTLEY'S. TELEGRAMS: "HAULING," BIRMINGHAM. 1631

**H. & T. DANKS (NETHERTON) Ld.**
NETHERTON, DUDLEY, WORCS.
1507

Cornish Boilers

Lancashire Boilers

**STEAM TURBINES.**
**Richardsons, Westgarth & Co. Ltd.**
HARTLEPOOL, MIDDLESBROUGH & SUNDERLAND.
See large Advertisement, Aug. 17. 1320

HAVE YOU SEEN THE NEW BAR WHICH BURNS SUCCESSFULLY ANTHRACITE DUFF?
Turbine Furnace Co. Ltd.
238b, Gray's Inn Road, W.C.1.
See Advt. Dec. 21

**PAPER MILL MACHINERY**
**BERTRAMS LIMITED**
SCIENNES EDINBURGH

Makers of EFFICIENT FOUNDRY PLANT
THE CONSTRUCTIONAL ENG. CO., LTD.
CHARLES HENRY STREET, BIRMINGHAM.
See half page advert., Aug. 19, 1921. 987

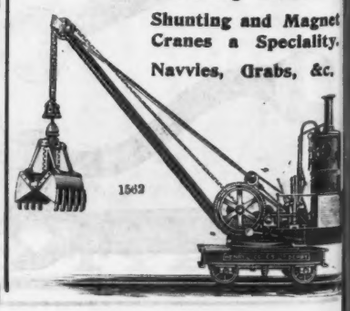
**J. TOMEY & SONS LTD.**
EUREKA GAUGE GLASS
ESTABLISHED 1853
ASTON, BIRMINGHAM. 1487

**A. BEEBEE, Studs, Bolts, Nuts, &c.**
WEDNESBURY. 3569

**THOS. SUDRON & Co., Ltd.,**
STOCKTON-ON-TEES.
1366
MAKERS OF MARINE AND VERTICAL TYPE BOILERS. SHIPS' MASTS. TANKS. MOORING BUOYS. STEEL LADLES, TUBING, Etc.

**J. G. KINCAID & CO. LTD.,**
GREENOCK,
Engineers and Boilermakers.
1647
See last and next week's illustrated half-page advt.

**HENRY J. COLES, Ltd.,**
**DERBY.**
*Makers of*
Steam and Electric Travelling Cranes.
Shunting and Magnet Cranes a Speciality.
Navvies, Grabs, &c.


1562

**WATER TUBE BOILERS. SUPERHEATERS, ECONOMISERS AND ALL ACCESSORIES.** 1632
The British Niclausse Boiler Co., Ltd.,
The Clock House, Arundel St., Strand, W.C. 2.

**THE VACUUM BRAKE CO., Ltd.**
3, 5 & 7, Old Queen Street,
LONDON, S.W.
Telephone: Victoria 3289.
Telegrams: SOLUTION, LONDON.
A B C and A 1 Codes used. 1128
For Large Advt. see page 61, Dec. 7.

**JOHN SPENCER, LD.** 1373
WEDNESBURY.
IRON & STEEL
**TUBES**
POLES, STEAM MAINS, TUBULAR PILES, &c.

**THE STEEL PIPE CO.**
LIMITED,
KIRKCALDY, N.B.
1493
See our large Advertisement on alternate weeks.

**HAMWORTHY**
OIL ENGINES,
PUMPS and AIR COMPRESSORS.
THE HAMWORTHY ENGINEERING CO., LTD.,
612 76, VICTORIA STREET, LONDON.

**CRANES**
Samuel Butler & Co., Ltd.,
Stanningley.
For illustrated advertisement see next week's issue. 1533

**Cling-Surface**
THE DAYS OF TIGHT BELTS ARE OVER.
enables belts to run slack without *slip*.
THOMAS & BISHOP, LTD., 37, TABERNACLE ST., E.C.

**ENTWISLE & CASS, LD.,**
Engineers, BOLTON.
For CENTRIFUGAL PUMPS, AIR COMPRESSORS, CLUTCHES, GEARING, CASTINGS up to 10 TONS, BLEACHING, DYEING & PRINTING MACHINERY. 1192

**FERGUSON BROS. (PORT GLASGOW) Ld.**
PORT GLASGOW,
ENGINEERS AND SHIPBUILDERS.
See Last and Next Week's Half-page Illustrated Advertisement. 1179

1315
The Consolidated Brake & Engineering Company Ltd
CAXTON HOUSE, WESTMINSTER, S.W. 1.
Phones: Vic. 2060-1. 'Grams: Peters, Parl. London.
Code: A.B.C. 6th Edition, 5 letter.

**PURE WATER**
for all purposes.
Particulars from 4361
The BUHRING'S Patent WATER PURIFYING Co.
146a, Queen Victoria Street, E.C. 4.

**STEEL CASTINGS**
STEEL AND IRON FORGINGS
THE DARLINGTON FORGE LTD.,
DARLINGTON. 729
Tele.: "FORGE, DARLINGTON." Tel. 3610
(See advertisement, page 84, Dec. 21.)

**Boulton & Paul**
**Go-down, Hangar or Warehouse**

THESE buildings have been made by us for many years. The construction is standardised in order to lower the cost of manufacture. All Steelwork and Galvanized Corrugated Sheets are of the best quality. Each building has one pair of sliding doors at each end, in addition to those at the sides. Sizes and Prices on application.

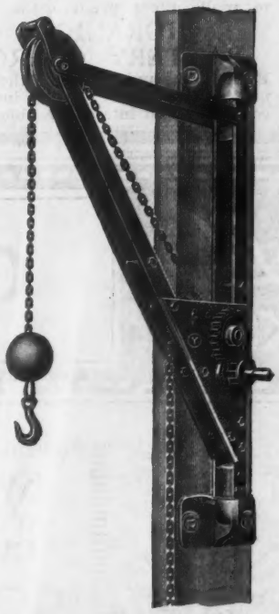
Throughout the world BOULTON & PAUL Buildings are known for reliability. Constructed on hygienic principles, they are admirably suited to the needs of tropical and semi-tropical countries. They are strong, rigid, well-built, perfect in every detail, and easily erected by unskilled labour. Prompt delivery can be made.

*Designs and Estimates prepared for any requirement. Write us stating your needs*

*Manufacturers of Bungalows, Market Buildings, Tea and Rubber Factories, Coolie Lines, Light Bridges, Workshops, etc.*

**Boulton & Paul Ltd**
Telegrams: BOULTON NORWICH **NORWICH** Telephone: NORWICH 60 (5 lines)
LONDON OFFICE: 135-137, QUEEN VICTORIA ST. E.C.
Telegrams: Boulticue, Cent London. Telephone 4642 Cent

**YOUNGS,**



Light Swing Jib Crane for Doorways, Vans, etc.

Write for List No. 27.

**RYLAND STREET WORKS, BIRMINGHAM.** 1371

**J & E HALL LTD**
REFRIGERATING MACHINES FOR ALL PURPOSES
HALLFORD LORRIES
LONDON OFFICE:
10, ST. SWITHIN'S LANE, E.C. 4.
Telephones:
Central 3540. Dartford 201.
DARTFORD
1736

**KAYE'S**
LATEST
"FORCE FEED"
MOTOR AND ENGINEERS'
**SEAMLESS STEEL OILCANS.**

Also **THE "K" OIL ECONOMISER**

STORAGE CAPACITY FROM 1 to 100 GALLONS AS MAY BE DESIRED.

Contractors to H.M. Navy, War Dept., Home Office, and Indian State Railways.

SOLE MAKERS:—
**Joseph Kaye & Sons**
LTD., 7006
Established 1864.
LOCK WORKS, LEEDS
AND
93, HIGH HOLBORN,
LONDON, W.C. 1.

# BROUGHTON COPPER Co Ld

WORKS: MANCHESTER AND DITTON (near Widnes).

COPPER SMELTERS COPPER AND BRASS MANUFACTURERS.
FLUID-COMPRESSED HYDRAULIC-FORGED
COPPER, BRASS AND BRONZE TUBES AND CYLINDERS
COPPER INGOTS. BARS. SHEETS &c. ELECTRO-COPPERING.

OFFICES: MANCHESTER. BRANCH OFFICES LONDON AND GLASGOW.

MANCHESTER.

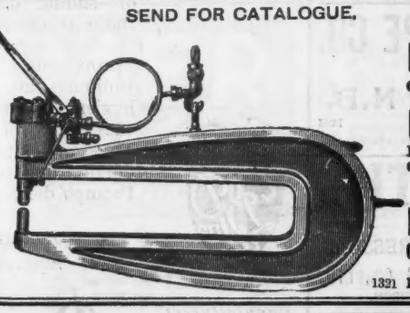
507

# W. B. BROWN & CO. (BANKHALL), Ld
GLOBE WORKS LIVERPOOL.

9275

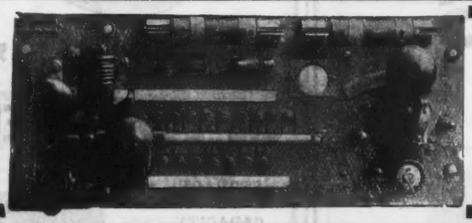
HIGH GRADE.
STEEL WIRE ROPES FOR ENGINEERING.

SEND FOR CATALOGUE.



OIL MILL MACHINERY
OF ALL DESCRIPTION
HYDRAULIC
Rivetters, Flangers, Press
Cranes, Railway Carriage
Wheel Machinery, &c.
MUSGRAVE BROS.
Crown Point Foundry, LEED
Contractors to the
1321 HOME AND FOREIGN GOVERNME

THE BRITISH SPECIALISTS. (ON ADMIRALTY WAR DEPT. AND COLONIAL LISTS.)
# HYDRAULIC LEATHERS
LEATHERS COMPANY LIMITED ALTRINCHAM.

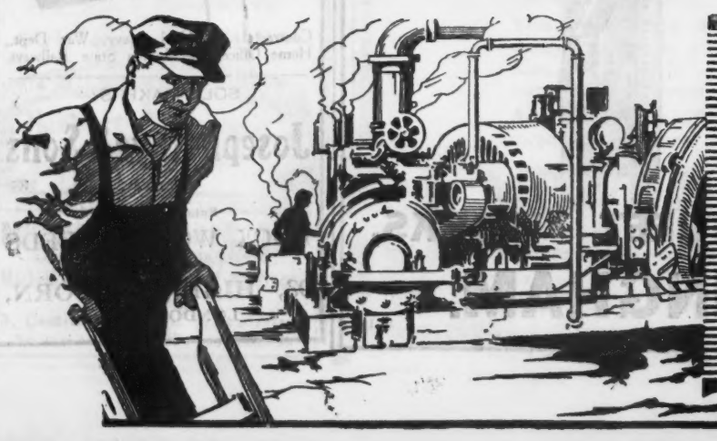


ELECTRIC VEHICLES AND TRUCKS have sprung into enormous demand for transport of merchandise. To keep these vehicles in service, to keep the batteries charged, to make them produce the maximum results, instal
"IGRANIC" UNIT TYPE BATTERY CHARGING PANELS.
Built on the unit principle they can be extended unit by unit as the fleet of vehicles increases. Each unit is self-contained and interchangeable.

IGRANIC ELECTRIC Co. Ltd.
149, Queen Victoria St., LONDON.
Works: Elstow Road, BEDFORD
Write for Leaflet No. 780-C31. 1171

# F. Wigglesworth & Co Ltd
SHIPLEY ~ YORKS

# GEARING
1499



We are the Largest Buyers of Non-Ferrous
SCRAP METAL
and are always open for
SCRAP BRASS, GUN METAL, COPPER, TURNINGS & BORINGS ETC. ETC.
H. B. BARNARD & SONS
GLYN STREET · VAUXHALL · LONDON · S.E.11
Telephone: HOP 4520.
Telegrams: "METALCIBLES" LONDON.
1500

MECHANICAL STOKERS
COAL ELEVATORS & CONVEYORS

ED. BENNIS & CO. LTD
LITTLE HULTON · BOLTON · & 28 VICTORIA ST. LONDON S.W.
LOOK OUT FOR FULL-PAGE ANNOUNCEMENT ON JAN. 4.

SUCTION & STEAM JET ASH REMOVAL PLANT

574

HUDSON Patent Cylindrical Cross Tube BOILER
THOMAS HUDSON, LTD
SHEEPFORD BOILER WORKS
COATBRIDGE
700 See Illustrated Advt. page 60, Dec. 14.

ROBERT STEPHENSON & CO.,
LOCOMOTIVE BUILDERS, DARLINGTON. & LTD.
London Office:—17, Victoria St., Westminster.
LOCOMOTIVES for all gauges and services.
Telegrams—Rocket, Darlington; Altiscope, London.
Nat. Tel.—3700 Darlington; 050 Victoria.
Codes—A B C 5th Edition, Engineering Standards, Engineering Telegraph.
See our illustrated Advt. Dec. 14. 1131

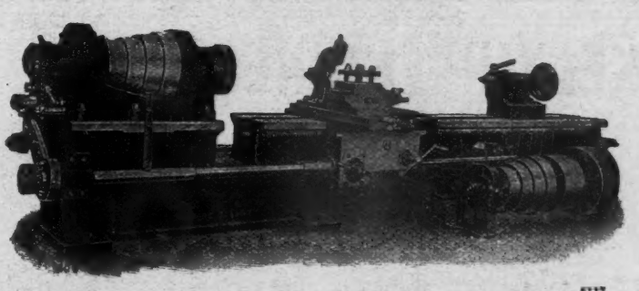
PATENT AND GOLD MEDAL
GEIPEL STEAM TRAP
Used by the Admiralty on 100 Warships.
Costs less than half of any other high-class trap for given discharge capacity.
VULCAN WORKS, ST. THOMAS ST. S.E. 1.

Paterson
WATER WORKS ENGINEERS
ENGINEERING COMPANY LTD
WINDSOR HOUSE KINGSWAY
1583

CRANES
OF HIGHEST QUALITY. 590

ELECTRIC OVERHEADS OUR SPECIALITY.
Any other type also supplied. Send us your enquiries.
JOSEPH BOOTH & BROS., LTD.,
RODLEY - - - - LEEDS.
LONDON REPRESENTATIVE:
W. CAIRNS BOOTH, Parliament Mansions, Victoria Street, London, S.W. 1.

DEMPSTER, MOORE & CO., LTD.,
Engineers, GLASGOW.



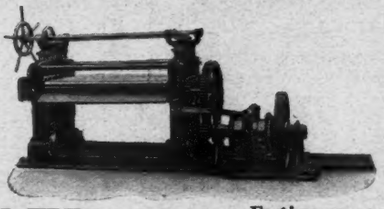
5117
Modern High-Speed Machine Tools.

FOR COAL, COKE, ASHES, SAND, GRAVEL, MILLSCALE, MUD, CLAY, MACADAM, ETC.

COOPER-WILLMOTT
SINGLE CHAIN OR WIRE ROPE
GRABS
MAKERS:
SEDGWICK & Co.,
MILLWALL,
LONDON,
'Phone: EAST 748.
1662

SHEET FLATTENING. SHEET STRAIGHTENING. SHEET SOFTENING.

Our 13 Roll Machine illustrated, straightens, flattens and levels sheets. It renders them soft, ductile and pliable for further working, and does this at the rate of 150 feet per minute with one operator.



J. BIGWOOD & SON, LTD., Engineers, Wolverhampton. (Est. 1874.)

REINFORCED CONCRETE.
CHRISTIANI & NIELSEN
Specialists in
DESIGN & CONSTRUCTION.
PRELIMINARY DESIGNS AND ESTIMATES SUPPLIED WITHOUT COST OR OBLIGATION. 1477
72 & 74, Victoria Street, Westminster, S.W. 1.
Telephone: - - Vic. 3565 and 3568.

MARSHALL, FLEMING & CO., LTD., ENGINEERS, MOTHERWELL
Contractors to the Admiralty, War Office, &c., &c.

100-TON OVERHEAD ELECTRIC CRANE. 1104

ELECTRIC and HAND TRAVELLERS.
ELECTRIC GOLIATH CRANES.
ELECTRIC WHARF CRANES.
1,000 STEAM CRANES.

LONDON OFFICE: 39, Victoria St., Westminster, S.W.1.
NEWCASTLE-ON-TYNE Office: 1, St. Nicholas Buildings.

Established 1838.
HOYT LEATHER BELTING
"FLINTSTONE" PURE OAK TANNED.

The Best is the Cheapest for all Drives.
"Turtle" 1565 Brand Guaranteed Waterproof.
BALDERSTON & CO., LTD.
201, ST. VINCENT STREET, GLASGOW.

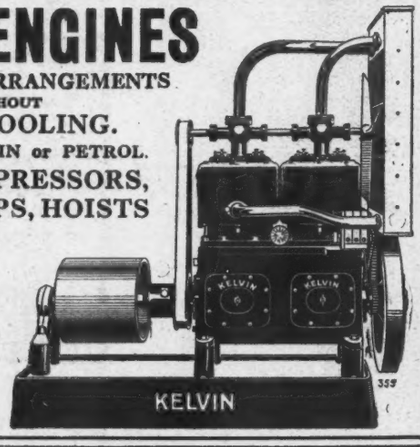
NOTHING NEEDED BUT A HAMMER.

"ALLIGATOR" FLEXIBLE STEEL BELT LACING.

We shall be pleased to send *A FREE SAMPLE* to anyone interested in Economical, Efficient Belt Lacing. Specify width of belt and thickness. 1318

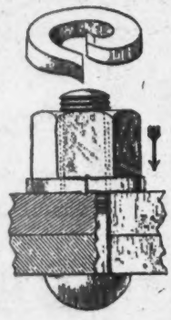
J. B. STONE & CO., LTD.,
135, FINSBURY PAVEMENT, LONDON, E.C. 2.
AND 522, SOUTH CLINTON STREET, CHICAGO, ILL., U.S.A.

KELVIN ENGINES
70 STANDARD ARRANGEMENTS
WITH OR WITHOUT
RADIATOR COOLING.
3 to 60 HP. on PARAFFIN or PETROL.
For AIR COMPRESSORS, DYNAMOS, PUMPS, HOISTS
and all jobs requiring a power unit of absolute dependability. 1529




Complete Manufacturers—
THE BERGIUS COMPANY, LTD.
254, DOBBIE'S LOAN,
GLASGOW.

"KOLOK"
POSITIVE
LOCK WASHERS
PREVENT VIBRATION.
*The one and only perfect locking device on the market.*



Avoid Imitations by specifying "KOLOK."
Made and Sold in 12 Months—158,000,000

POSITIVE LOCK WASHER CO.,
118-122, James Watt Street, GLASGOW. 1505

GRAFTON & CO.
CONTRACTORS TO H.M. GOVERNMENT,
CYCLOPS WORKS,
Telegrams—Grafton, Bedford.
BEDFORD.

Illustrated Descriptive Price List free on application.

SILVER MEDAL, Inventions Exhibition London, 1885. GOLD MEDAL, Paris, 1900.
GRAND PRIX and GOLD MEDAL, Franco-British Exhibition, London, 1908.
GRAND PRIX, Buenos Aires Exhibition, 1910. 1113

JOHN OAKEY & SONS, LTD.
GENUINE EMERY, EMERY WHEELS 1208
EMERY CLOTH, For all Purposes.
Wellington Mills, GLASS & FLINT PAPERS,
WESTMINSTER BRIDGE ROAD,
LONDON, S.E. 1. BLACK LEAD, &c.

JOHN RUSSELL & CO., LD.
WALSALL.
LAPWELDED AND SOLID-DRAWN
TRADE MARK. TUBES 1629 TRADE MARK.
FOR LOCOMOTIVE AND OTHER BOILERS, AND GENERAL ENGINEERING PURPOSES.
LOOSE FLANGE AND VICTAULIC JOINTS SUPPLIED.

SIEBE, GORMAN & CO'S
DIVING APPARATUS
Sole Makers to the BRITISH ADMIRALTY.

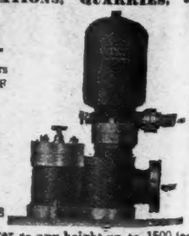
SMOKE HELMETS
OXYGEN BREATHING APPARATUS
for Poisonous Air.
MEDICAL OXYGEN APPARATUS
and
AIR COMPRESSORS AND VACUUM PUMPS
IMMEDIATE DELIVERY. 905

187, WESTMINSTER BRIDGE ROAD, LONDON, S.E.
Telegrams: "Siebe, Lamb, London." Cables: "Siebe, London."
Telephone No. Hop. 3401 (2 lines).

"WOODITE,"
*The Best Material for* GAUGE GLASS RINGS & STEAM PACKINGS
For Valves, Joint Rings, Pump Cups,
Ram Rings, Packing Rings and Sheeting
in all Sizes and Sections.
Contractors to H.M. Government, Admiralty, War Office, Post Office, India Office, and the Colonial and Foreign Governments.
*The Best Material for all High Pressure Steam or Electrical Installations.*
PRICE LIST AND FULL PARTICULARS ON APPLICATION TO— 5789
WOODITE COMPANY,
Mitcham Common, Surrey, Eng.
Tel. Address: "Woodite, Mitcham." Telephone No.: Mitcham, 1502.

LIDGERWOOD
DRAGLINE EXCAVATORS.
MINE HOISTS.
HOISTS.
GRABS.
WINCHES. 1186
PILE DRIVERS.
CABLEWAYS & DERRICKS.
TELEGRAMS: LIDGERWOOD, LONDON. TELEPHONES: LONDON WALL 8192, 7422.
LIDGERWOOD Ltd
FRIARS HOUSE, NEW BROAD STREET, LONDON, E.C. 2.

WATER SUPPLY OF ESTATES, VILLAGES, RAILWAY STATIONS, QUARRIES, &c.
BY
**BLAKE'S RAMS**
Advise your Customers to install these SELF ACTING PUMPS
NO COAL.
NO OIL.
NO STEAM.
NO LABOUR.
NO COST FOR MOTIVE POWER. 958

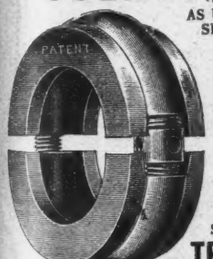


Rams will raise water to any height up to 1500 feet.
*Write for our book No. 34 on WATER SUPPLY.*
JOHN BLAKE, LTD., ACCRINGTON, LANCS.

THE
**CLEVELAND BRIDGE AND ENGINEERING CO., LTD.**
*Specialists in the Design, Manufacture, and Erection of Bridges, Girders Roofs, Warehouses, and all classes of Iron and Steel Constructional Work.*
HEAD OFFICE AND WORKS— 1461
**DARLINGTON.**

**T. & R. LEES LTD. Hollinwood.**
**WOOD WORKING MACHINERY.**

**"SPLIT GRIP" COLLAR** (TRIER'S PATENT)
AS USEFUL AS THE SPLIT PULLEY.
*IN HALVES.*
*NO* Set Screw to cause Accidents.
Grips like a Vice.
Fixed or Removed without Disturbance.



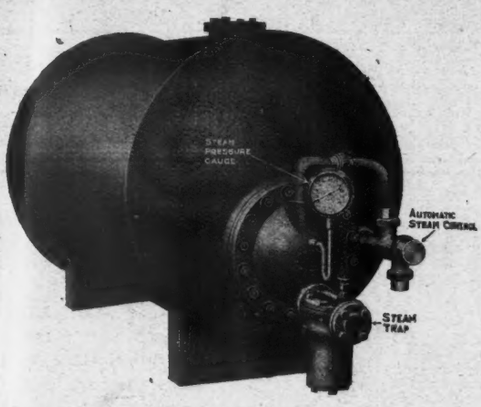

Sole Makers:
**TRIER Bros.**
*38, VICTORIA ST., WESTMINSTER. LONDON. S. W. 1.* LIMITED, 1319

On Admiralty List.
**BODLEY BROS. & Co. Ld.**
Engineers, Millwrights, Boiler Makers and Iron and Brass Founders.
OLD QUAY FOUNDRY, **EXETER.**

SPUR, BEVEL, MITRE, MORTICE AND **WORM WHEELS,**
Machine Moulded
ALSO
**TEETH CUT TO SHAPE**
By Special Machinery.
Telegraphic Address— 1291
BODLEY, EXETER
ESTABLISHED 1790.

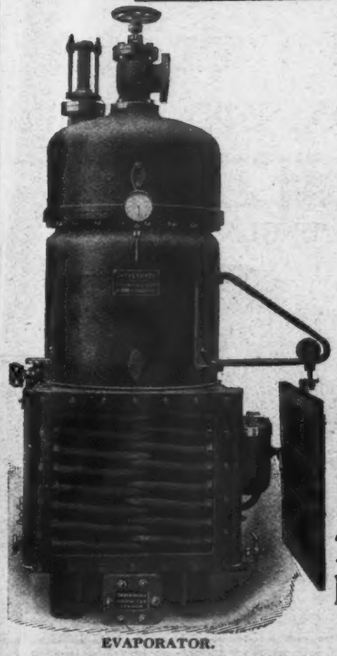
*"SHONE"*
**PNEUMATIC EJECTORS**
For RAISING SEWAGE, SLUDGE, PAIL CONTENTS, &c.
IS USED AT
RANGOON, KARACHI, BOMBAY, EASTBOURNE, NORWICH, GOSPORT, HOUSES OF PARLIAMENT, Westminster, and many other places.
AIR COMPRESSING MACHINERY
COMPRESSED AIR LIFTS For Raising Water from Wells, Boreholes, &c.
*For Pamphlets and full particulars apply to the Manufacturers—*
1535
**HUGHES & LANCASTER, Ld., 16, Victoria St., LONDON, S.W.**

**WRIGHT'S CALORIFIERS**




SEND YOUR ENQUIRIES FOR:— CALORIFIERS OF ANY SIZE FOR ANY PURPOSE; FOR USE WITH EITHER LIVE OR EXHAUST STEAM
TO:—
**WRIGHT'S FORGE & ENGINEERING Co., Ld.**
'PHONE—32 Tipton. 6585 London Wall.
WIRE—Forgings, Tipton. Penetration, Stock, London.
TIPTON, Staffs. AND 57, Bishopsgate, LONDON, E.C. 0 8753

**CAIRD & RAYNER,**
Admiralty and War Office Contractors.



EVAPORATOR.

**EVAPORATORS**
Live or Exhaust Steam Types.
**FEED WATER HEATERS**
Live or Exhaust Steam Types.
**FEED WATER FILTERS**
Pressure or Gravitation Types.
**EXHAUST STEAM OIL SEPARATORS**
Improved Type.
COMPLETE
**FRESH WATER DISTILLING INSTALLATIONS**
(All Sizes). For LAND or MARINE USE.
**BOILER FEED PUMPS.**
Vertical Single-Cylinder Direct-Acting Type.
**777, Commercial Road, Limehouse, London, E.14.**
Tel. Address:—"VAPORIZE, LONDON."
Telephone:—EAST 210. 1598

**BULL'S METAL & MELLOID CO.**
HEAD OFFICE AND WORKS: LIMITED. YOKER, near GLASGOW.
TELEGRAMS: "MELLOID, YOKER."
BULL'S METAL.—Propellers, Bars, Sheets, Pump Rods, Valve Spindles, Condenser Stays & Plates, &c.
MELLOID. (Reg. Trade Mark and Patented.)—Condenser Tubes, Plates and Stays, Boiler Tubes, Stays and Plates, Fire-box Plates, Bars, Sheets, Valves, &c.
WHITE METALS.—Babbitts, Plastic, &c. 1665

**The CLYDE STRUCTURAL IRON CO., Ltd.,**
*Clydeside Ironworks, Scotstoun, Glasgow.*
MANUFACTURERS OF 1210
**Iron & Steel Roofs, Buildings, Workshops, &c., &c.**
LONDON OFFICE: 48, Cornhill, E.C.

**ELECTRO-MAGNETIC CHUCKS**
*FOR ACCURATE GRINDING.*
RAPID MAGNETTING MACHINE CO., Ltd.,
CRESCENT, BIRMINGHAM. O9526
See illustrated advert. last week and next.

**SMITH'S RELIABLE CRANES**
THOMAS SMITH & SONS (RODLEY), LTD., NR. LEEDS.

**LOCOMOTIVES FROM STOCK.**
ALL GAUGES AND SIZES. 1606

**KERR STUART'S**
5, Broad St. Place, London, E.C.

**Aerial Ropeways.**
**BRECO System.**
BRITISH ROPEWAY ENGINEERING CO., LTD., 9782
34, FENCHURCH STREET, E.C.

**HALL PUMPS**
FOR ALL CLASSES OF BOILER FEEDING, &c., &c.
**J.P. HALL & SONS, Ld.**
PETERBOROUGH.

**MECHANS LIMITED,**
Engineers & Contractors,
SCOTSTOUN IRONWORKS, GLASGOW.
LONDON OFFICE:
28, Victoria Street, Westminster, S.W.
See Illustrated Advertisement appearing Dec. 7 and Jan. 4. 1724

**MACKIES**
(1921) LTD.
(Late of Reading)
Kingswood Hill Works, BRISTOL
FOR 1710
**POWER TRANSMISSIONS.**

**BELLISS & MORCOM**
BIRMINGHAM. *LTD.*
Self-lubricating Steam Engines, Turbines, Air & Gas Compressors, Condensing Plants, Heavy Oil Engines, Paraffin Engines, Pneumatic Hose Couplings.
See Illustrated Advt. page 62, Dec. 21. 1235

Repetition Iron Castings
**Wallwork**
HENRY WALLWORK & CO., Ltd., MANCHESTER

**PULSATING PUMPS**
**TURNSTILES**
AND GENERAL ENGINEERING.
**W. T. ELLISON & CO., LTD.**
Irlams-o'-th'-Height,
**MANCHESTER.**
Telegrams:—"Illisons Ltd.," Irlams-o'-th'-Height.
Telegrams: No. 20, Pendleton. O 9606

LONDON OFFICE:
56, Leadenhall St., E.C. 3.
GLASGOW OFFICE:
90 Mitchell Street, Glasgow.

On Government, India Office and Leading Railway Companies' Lists.

Telegrams: Tensile, Wednesbury.
Telephone: 68 Wednesbury.

THE Midland Bright Drawn Steel and ENGINEERING CO., Wednesbury. 1426

MANUFACTURERS OF WELDLESS STEEL LOCO TUBES,
BRIGHT DRAWN BARS, BLUE PLANISHED BARS, BLACKREELED BARS, TUBE FERRULES.

IRON CASTINGS.

MACHINE MOULDED CASTINGS A SPECIALITY. 6814

A. RANSOME & CO., LTD., Stanley Works, Newark-on-Trent.

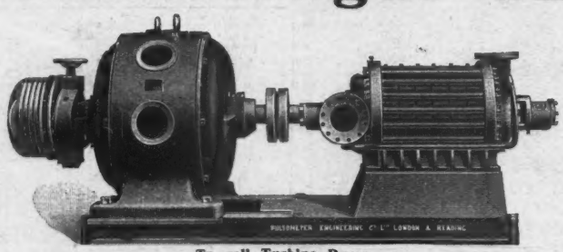
ELECTRIC STEAM HYDRAULIC CRANES

GEORGE RUSSELL & Co. LTD. MOTHERWELL. N.B. 1136

High Efficiency

Centrifugal and Turbine Pumps

For all Lifts up to 3000 Feet.



T7. cell Turbine Pump.

Our pumps are made in such a variety of types and sizes that we can usually offer one to meet exactly any specified duty. Our lists give full information as to the quantity thrown on various lifts and the horse power required for that quantity.

1186

*Write for List No. 885.*

11, Tothill Street, LONDON, S.W. 1.

Pulsometer Engineering Co. Ltd

Nine Elms Works, READING.

BRIGHT COMPRESSED

SHAFTING 1125

ROUNDS. HEXAGONS. FLATS. SQUARES.

KIRKSTALL FORGE CO., LTD., NEAR LEEDS.

W. G. BAGNALL, LTD.,

STAFFORD, ENGLAND.

MAKERS OF
Tipping Trucks, Sugar Cane Wagons, Turntables, Switches, &c.

BUILDERS OF
LOCOMOTIVES weighing from 3 to 50 tons, for any gauge, of highest-class workmanship and material, at competitive prices.

0 651

Code Used:—A B C.

Speciality: NARROW-GAUGE LOCOMOTIVES.

Telegrams: Bagnall, Stafford.

Printed for the Proprietors by HARRISON & SONS, LTD., at the Bedford Press, 20 & 21, Bedfordbury, in the Parish of St. Martins-in-the-Fields, and Published by CHARLES ROBERT JOHNSON, at the Offices of ENGINEERING, 35 & 36, Bedford Street, in the Parish of St. Paul, Covent Garden, both in the County of Middlesex.—December 28th, 1923.